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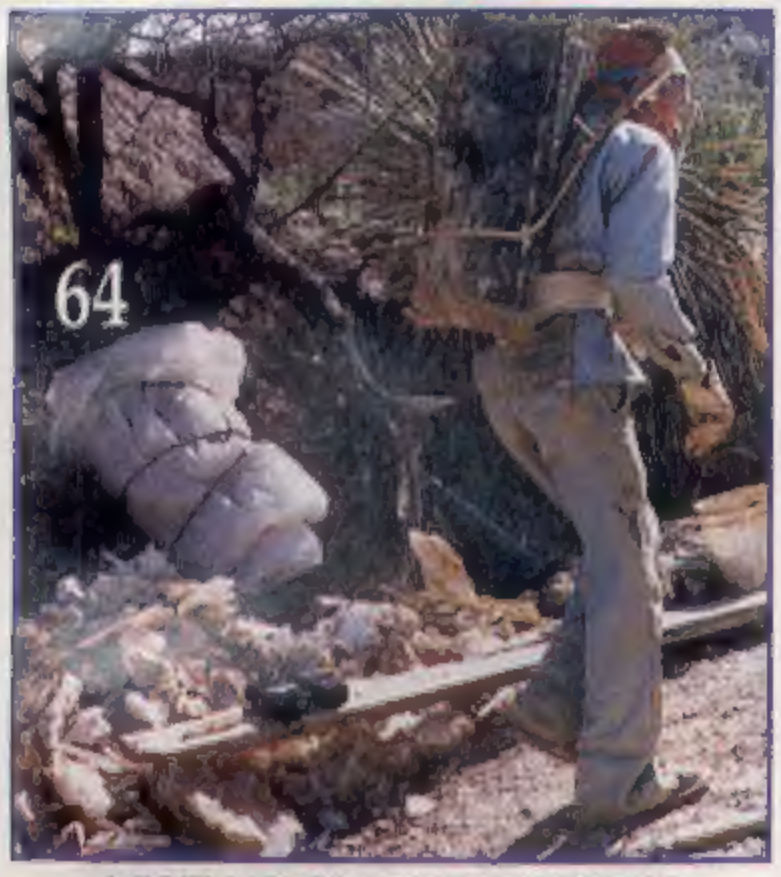

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COVER: This month's cover features Arizona's copper minerals: a natural specimen of azurite with chrysocolla (center), a polished slice of azurite stalactite (right), and a piece of chrysocolla (left). Specimens courtesy of Pala Properties International, Fallbrook, CA. (Photo by Harold and Erica Van Pelt Photographers, Los Angeles, CA)

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FIELD-TRIP BASICS

Tips to Make Your Field Trips Fun and Safe

by Bob Jones

If you've been field collecting for a few years, you probably think you know it all. Forget that! If you're like me, you've gotten sloppy and careless, so it might be a good idea to review some of the necessities for field trips, and some of the frills, too.

The newest "gadget" for field tripping is actually a necessary safety device. It's a cellular phone. I live and collect in the desert, including forays into Mexico's Sonora and Chihuahua deserts. Time and again, I read or hear about someone getting lost or stuck somewhere between a saguaro and jumping cholla. In an area where water holes are far apart and there are only ruts and trails once you leave the pavement, it's smart to carry along an instrument for communicating with the civilized world. If you don't know how to send smoke signals, a good cell phone is your best friend in the desert.

Your vehicle is your other best friend. Even if you are only going to a well-known, easy-to-reach collecting area, you sure don't want your engine to overheat or quit. Too many people fail to check radiator hoses and fan belts, and even fail to carry extra water. How foolish! Just driving the highways is reason enough to carry water and check everything before you take off. It used to be that there was a gas station at every intersection and every exit ramp. Not any more. You need to be even more self-reliant than ever.

In spite of computerized engines and hydraulic gadgets, a good toolkit can still be useful. Something as annoying as a sun visor falling into your lap in the late afternoon as you jounce down a rough road is easily fixed with a small tool. Seems silly to even mention it? Sure it is. But a few tools are always useful.

I can recall collecting with my two boys at about 12,000 feet in Colorado's San Juan Mountains one summer. We were heading back to Silverton in the late afternoon when we hit a rock that stripped the spring hanger right off the right rear spring. The drive shaft splines pulled out, the leaf springs fell like confetti along the trail, and the whole axle assembly shifted back so the right wheel was against the bumper! No small tool-

kit would do this time, but I had thrown my toolbox into the 4x4 before we left. So we collected the parts, and I got underneath the vehicle and disconnected the spring hanger while the boys went in search of a long lever.

Outside a nearby mine tunnel was a length of air pipe, just right for levering the entire axle forward while I lined up the disconnected splines. With that accomplished, I stacked the spring leaves properly, slipped them into place in the hanger, and tightened everything down. In less than two hours, and while it was still light, we were able to limp back into town, 10 miles away. Luckily, no brake lines or fuel lines had been parted, though when we reached pavement the old 4x4 shimmied like a Broadway dancer at 25 mph. You can never know what might happen on a field trip, so you have to be prepared for anything.

Most folks go on day trips, but now and again an overnighter or long weekend field trip looms up. You can list the sleeping necessities, but how about a thermal blanket? It is compact, light and has very specific uses. Some of those chemical glow sticks that give off light for hours are always worth having. I've gotten out of a mine using such a light source when my carbide lamp broke. I try to carry three sources of light whenever I venture underground. A chemical pocket warmer isn't such a bad idea, either. Most mines are pretty chilly.

On one underground excursion, my collecting partner dropped his sledgehammer. It landed on my foot, breaking two toes. In trying to cinch my boot tighter, I broke the lace. Now, who would think something as simple as a shoelace was important? It is!

Another time we were collecting underground, I noticed a big rock slab hanging along one wall where we wanted to collect. I told my partner to move away so I could pry the slab loose. I did, and it shattered as if exploding. One sharp shard hit my partner in the thigh and, of course, a vessel was opened. Blood spurted out in a thin stream. Thanks to a first-aid kit and a bandanna, we stanched the flow, and the collecting trip was saved along with his blood.

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When collecting underground, it's a good idea to take along more than one light source. (Photos by the author)

Wear sturdy shoes for clambering over rough terrain, and always wear eye protection when hammering at rocks.

Field-Trip Basics/ *from page 13*

Another item worth carrying in the desert is a pistol—not for sport, but for protection. It is also a great signaling device when you get separated from your partner. And once in a while, it becomes necessary to use it for protection. My choice is a .22 caliber pistol with birdshot bullets. They work great on a snake that's within striking distance and poised to nail you. A buddy of mine once sat on a rock to rest before realizing there was a rattler under the overhang beneath him. He really didn't relish the idea of getting up and having the snake nail him in the posterior. Of course, he also didn't like the idea of me placing a shot a few inches from that same bit of his anatomy, but it was the right answer in this case.

Before you take a gun out in public, be sure you know how to handle it properly and fulfill the legal licensing requirements. Gun-safety classes are highly recommended.

Living and collecting in the desert, I've probably slept under the stars more often than I've visited museums. A complete, but lightweight, camping kit is essential. Still, there are a few tricks to remember.

You undoubtedly already know to hang your food in a tree some distance from your camp. Otherwise, you might go hungry while some thieving animal enjoys a feast.

Of course, if you go collecting frequently, you never know when you are going to run into some wild creature. On the East Coast it can be bears, copperheads, rattlers and the like. In the desert, it's wild pigs, snakes, bears and my favorite pussy cat, the mountain lion. These cats are beautiful animals, but only from afar. My close encounter with one was not pleasant, though it ended without injury.

Some years ago, a group of us went collecting in an old mine on the Indian reservation south of Casa Grande, Arizona. The abandoned mine was a good source of nice dogtooth calcites in huge plates, as well as sharp galena crystals with a sparkling coating of cerussite. Odd, flesh-colored barite was also found now and again.

When we entered the main tunnel, we noticed some evidence of an animal having lived in there, but there was no creature. So we proceeded, and spent the day enjoying our collecting success. By the time we were ready to leave, it was dark outside. Two of us who were ready first started out, intending to wait at the tunnel mouth for our companions. As we sat there in the dark, we realized there was movement in the nearby brush. Then the brush began to growl! The mine's resident, a mountain lion, had arrived. Luckily, our buddies showed up just then and we hightailed it down the slope to our campsite and the safety of our trucks.

As for incidental tools, things like tweezers and pliers are standard fare in the desert. They are useful for removing the cactus spines you'll inevitably collect. Another seldom-thought-of item is waterproof matches. Just take ordinary matches and dip the heads in wax. The wax will rub off when you strike the match tip. A small waterproof container for storing them is also a must; they are available at any camping equipment store. I also like to carry a small spray bottle. It's handy for taking a quick look at a rock I think might be worth keeping. And a snakebite kit takes up little space.

A couple of other necessities, if you collect in the mountains or in forested areas, are insect repellent and hydrocortisone. One deters most insects, and the other is a relatively recent over-the-counter medication that controls the itching their bites cause.

While hunting for rock specimens, keep your eyes peeled for snakes, too.

Emergency supplies are so compact and easy to carry there's no need to be caught without them.

Small things like shoelaces and cellular phones can become quite important when you don't have them.

I had need of both on one collecting trip into Canada. We were after the beautifully bright yellow, fluorescing wernerite, one of Canada's premier and noteworthy fluorescents. It was June, a good time for those dreaded black flies, and a bad time for collectors. Somehow, those no-see-ums, as the Indians call them, manage to get inside your clothes, down your neck, up your pant legs, into the slit in a buttoned sleeve, and so on. They nip flesh, leaving behind an irritant. My welts—all 1 million of them, it seemed—lasted all summer. In those days, there was no hydrocortisone, much to my discomfort.

A number of the paperback collecting guides and books available offer a starter list of equipment and supplies for field collecting and camping. I got my start with Fred Pough's *Field Guide to Rocks and Minerals* back in the early '50s. Audubon's *Field Guide to North American Rocks and Minerals* is another useful source for getting started. Any good bookstore is likely to carry them. And don't forget the Scout manual for camping. It's based on a century of experience. But the most important item to take on a collecting trip is your common sense, coupled with alertness. Above all, have fun!

Shop Talk

by William A. Kappele

Lost Wax Casting

I think that one of the most rewarding manifestations of the jewelry-making hobby is lost wax casting. A wide variety of delicately detailed objects may be made by beginners and experts alike. The possible materials range from very inexpensive casting grains to very expensive gold. Similarly, the equipment can range from a clay flowerpot on a stove to a kiln costing hundreds of dollars, or from a simple propane torch from the hardware store to a specialized jeweler's torch. Getting a quality cast from the simple equipment may take more tries, but it can be just as good as one made with the top-of-the-line equipment.

The lost wax process has been around for a long, long time; it was used to cast bronze as far back as 2230 B.C. If you want to impress your neighbors, the French term for lost wax is *ciré perdue*. If you tell them you made your gold widget using lost wax, they will probably think you misplaced something.

Actually, the lost wax process is very simple in concept. First, a model of the object to be cast is constructed in a special type of wax. The model is then encased in a mold material that will stand the heat of molten metal. The mold containing the wax model is heated, and the molten wax runs out or burns up, leaving a cavity in the mold in the shape of the model. Then molten metal is poured or forced into the cavity and allowed to cool. The mold is either broken or dissolved away, leaving an exact replica of the wax model in metal. Of course, this is an oversimplification. The equipment needed in your shop is not very complicated, though.

You can make your own wax models, but many of *Rock & Gem's* advertisers sell ready-made wax models in a mind-boggling array of shapes, from rings to doodads. These ready-made models are great for getting started.

You will need some way to heat the mold to get the wax out. The ideal way is with a kiln, but you may not want to put out that much money until you find out if you like casting. A clay flowerpot on an electric hot plate will do the job.

If you begin with an inexpensive, low-temperature casting alloy, you can use a common propane torch for heat. If you fall in love with casting and want to upgrade to a jeweler's torch, you can always use the propane torch to put in that new water heater. Oh! You didn't know it was leaking?

Of course, when you have melted the metal, you have to have a way of getting it into the mold. There are centrifugal casters, pressure casters and vacuum casters on the market, but good old steam will do the job just fine.

When you get a little experience, you can use materials other than wax for models. You can cast insects, plant material, acorns, pine cones, fabric and almost anything else that can be burned out of the mold.

If you have access to the Internet, go to www.rockhounds.com and look for the many, many past *Rock & Gem* articles on lost wax casting.

Go forth and cast.

Please feel free to contact me if you have a suggestion or comment about this or any of my Shop Talk columns. My e-mail is quappell@ix.netcom.com, or write to me at 25231 Pericia Drive, Mission Viejo, CA 92691.

Field Trip of Dreams

Two Montana Rockhounds Turn Their Discovery into a Business

The Whitehawk deposit produces marble in a wide variety of colors. (Photos by Scott Rose)

by Steve Voynick

Most of today's major mineral discoveries are made not by rockhounds, but by professional exploration geologists. That's certainly no surprise, as the professionals enjoy enormous advantages in specialized education, experience, technological support, and financial backing.

But Scott Rose and Kevin Hulst, two amateur prospectors from Helena, Montana, believe that rockhounds can still make big mineral discoveries. In fact, they've proved it.

In 1996, while searching the hills west of Helena for gold, Rose and Hulst found a huge deposit of top-grade marble. Since then, they have parlayed their discovery into not only a growing business, but also a learning experience in the fields of geology, mineral claiming, resource development, and mineral marketing. And while developing their marble deposit, they have now made a secondary strike of high-grade copper-gold-silver ores and fine specimens of malachite, azurite and chalcopyrite. Their prospecting achievements rank among the most exciting and unusual mineral finds made in Montana in many years.

Rose, an industrial security consultant, and Hulst, a professional delivery driver, both in their late 40s, became friends in 1986. Hulst, who was a rockhound and

amateur gold prospector, quickly got Rose interested in mineral collecting and placer mining. Together, they spent many weekends prospecting the western Montana hills. In 1996, after years of work with placer gold, they decided to take a crack at prospecting for hardrock gold.

"We were looking for gold-bearing quartz veins," Rose explains. "We'd probe the overburden with a steel rod to determine its depth. Then, if it was shallow, we'd pick and shovel our way down to bedrock to check it out."

At the bottom of one of those holes, a swing of a pick chipped the bedrock to expose a fresh, gleaming-white fracture surface.

"Its brilliance startled me," Rose remembers. "The sun glittered off that rock as if it were hitting a million tiny diamonds. When we dug more prospect holes, we found more of that same white rock, and I could somehow sense that we were chipping away at what was just the tip of a huge deposit. We were sitting there studying samples and wondering what type of rock we had found, when I noticed an albino red-tailed hawk in a tree behind me. It had a pink tail and pink eyes, but the rest of it, just like that rock, was pure white. I've never forgotten that moment."

For help in identifying the rock, Rose and Hulst sent samples to the Montana Bureau of Mines and Geology at Montana Tech of the University of Montana in nearby Butte. The bureau identified their samples as "class A" marble, the purest and most valuable commercial grade of marble.

The term "marble" has both industrial and mineralogical meanings. In industrial use, it refers to any crystalline rock consisting primarily of calcium carbonate (calcite) and calcium magnesium carbonate (dolomite) that is capable of taking a good polish.

Mineralogically speaking, "marble" refers to metamorphosed calcitic or dolomitic limestone. Limestone is a marine sedimentary rock consisting of at least 50 percent calcite or dolomite. To become marble, limestone must be heated sufficiently to temporarily convert the solid limestone beds into a plastic or even a liquid state. The resulting metamorphism alters the limestone chemically and physically. Chemically, the heat drives off many impurities, leaving behind relatively pure calcite or calcite-dolomite. Physically, the heat permits the calcite and dolomite to recrystallize into an interlocked mass of tiny, uniform, highly reflective crystals. High levels of heat and prolonged periods of metamorphism produce the highest grades of marble.

continued on next page

A 2-inch chalcopyrite nugget with delicate malachite veining, from the contact zone of the Whitehawk quarry.

A 6-inch specimen of bladed calcite crystals harvested from the contact zone.

An 8-inch-long composite specimen of bright blue azurite, green malachite and orange hematite.

Trip of Dreams/ *from page 29*

Many variables, including the chemical and physical properties of the original limestone and the duration and heat level of the metamorphic process, are involved in the creation of marble. Accordingly, its grades, purity, colors, textures and brilliance vary widely from deposit to deposit.

Although pure marble is snow-white, small amounts of accessory minerals create a wide color range. Hematite colors marble pink and red, while limonite creates yellows and browns. Hornblende and diopside may impart green tints, while residual carbonaceous materials produce grays and black. Uneven distribution of accessory minerals can also create attractive, "marbled" patterns of spots and veins.

After confirming the mineralogical identity of their discovery, Rose and Hulst sent samples to laboratories that specialize in the analysis of carbonate minerals. These labs analyzed the samples for brilliance and chemical composition, the two key properties that determine the value and potential commercial uses of marble.

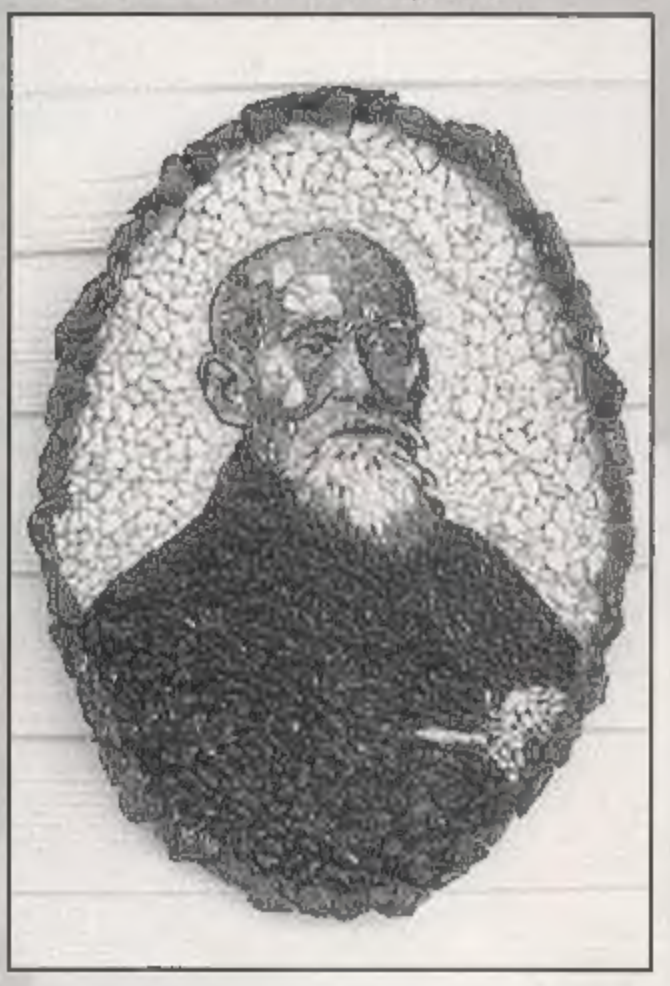
Marble's brightness, or ability to reflect light, is measured against the arbitrary 100-percent reflectivity value of pure, powdered magnesium oxide. The samples that Rose and Hulst provided tested to a very high brightness level of 90 percent, indicating that the marble had been completely recrystallized into a texture of tiny, uniform, reflective crystals. Highly reflective, or brilliant, marble is valuable for architectural, landscaping, decorative and artistic purposes.

Chemical analysis revealed a composition of about 94 percent calcite, 5.5 percent dolomite, and very small amounts of insoluble, noncarbonate minerals. Marble with high levels of purity is valuable as a source of calcium carbonate, a chemical with many industrial uses.

Convinced now that their discovery was commercially valuable, Rose and Hulst moved to acquire control of the deposit, which is located on federally owned land administered by the Bureau of Land Management (BLM). Like most rockhounds, they were familiar with the claiming provisions of the Mining Law of 1872, but marble is an unusual mineral resource, in that the provisions for development of marble deposits may not necessarily fall under this law. The manner in which marble is to be used determines whether it falls under the authority of the Mining Law of 1872 or that of the Mineral Leasing Act of 1920.

The Mineral Leasing Act regulates the development of deposits of petroleum, natural gas, coal, phosphate, potash and oil shale, and other resources that typically involve large tracts of land. Under the Leasing Act, mineral resources and land are not claimed, but leased. The federal government retains land ownership, and requires that oilmen and miners pay production royalties.

Marble deposits on federal land, when developed as sources of dimensional, or architectural, stone, fall under the Mineral Leasing Act of 1920. But deposits whose marble will be used as landscaping or decorative rock, or as a source of calcium carbonate, are locatable under the provisions of the Mining Law of 1872. Since they intended to mine and market marble for landscaping, decorative and chemical uses, Rose and Hulst were able to claim the deposit.



Marble from the Whitehawk quarry has a variety of artistic and decorative uses.

After locating 10 claims covering 200 acres, they retained a geologist who explained the origin of their marble deposit. Part of western Montana's Jefferson Formation, the marble had originated as a 750-foot-thick layer of dolomitic limestone deposited by a Devonian sea some 440 million years ago. When deposition of later marine sediments buried the limestone, relatively high temperatures generated by the pressure of deep burial may have partially recrystallized the limestone, resulting in an impure, low-grade, calcite-dolomite marble.

A second, more intensive metamorphic event occurred about 70 million years ago, when granodioritic magma intruded the ancient regional sediments to form the Boulder Batholith. The batholith, a series of intrusive sequences, extends for some 50 miles between Helena on the north and Butte on the south. One of the batholith's satellite plutons intruded into the beds of partially altered Devonian limestone, resulting in a classic episode of contact metamorphism.

The rising magma at the edge of the pluton made direct contact with the Devonian limestone beds, subjecting the limestone to intense heat. Great pressures forced associated, superheated, carbonate-rich solutions into the limestone beds. After the circulating solutions had driven off most of the magnesium present in the dolomitic limestone, the intense heat melted the limestone, allowing the recrystallization of the remaining calcium carbonate. The end product of this contact metamorphism was a deposit of nearly pure, highly reflective, high-grade marble, the uppermost sections of which Rose and Hulst discovered in April 1996.

Four months later, Rose and Hulst formed the Whitehawk Mineral Co., a development corporation named after that albino red-tailed hawk they had seen on the day of the discovery. Their first corporate project was to raise capital for drilling exploration, which could be conducted either by core or reverse-circulation drilling methods. Core drilling employs a small-diameter drill bit and string to recover solid core samples, usually 1⅞ inches in diameter. In reverse-circulation drilling, a 5-inch-diameter bit and string with a recirculating, "down and up" water flow recovers subterranean rock samples as a water slurry of small chips.

A drilling contractor explained that the chip samples recovered by reverse-circulation drilling would be sufficient to determine the extent of the deposit and the physical characteristics of the marble at depth. Furthermore, reverse-circulation drilling would be faster and considerably cheaper than core drilling.

In January 1997, the contractor drilled five reverse-circulation holes ranging in depth from 100 to 180 feet. The recovered chip samples showed nothing but high-grade marble all the way. And the successful drilling operation, conducted in winter temperatures as low as 50 degrees below zero, also demonstrated that the property could be mined year round.

After studying the drilling results and applying a bit of geological inference based on the known structure of the Jefferson Formation, geologists concluded that the marble beds extended to a depth of 750 feet. They also estimated the volume of marble within the deposit at more than 80 million tons—far more than Rose and Hulst had ever expected.

Exploratory drilling also unveiled the first mineralogical surprise at the Whitehawk quarry. Not all the marble was white, but came in a rainbow of colors: pinks, yellows, greens, blues, grays, black and all the intermediate shades.

Although colored marble is common, broad ranges of colors only rarely occur

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Trip of Dreams/ *from page 30*

within the same deposit. The broad variation in coloration of Whitehawk's marble is linked to the mineralization of the nearby Austin Mining District. The district was mineralized 70 million years ago by hydrothermal solutions associated with the intrusion of the Boulder Batholith—the same event that metamorphosed the Whitehawk marble. Since the 1870s, miners have extracted millions of dollars in copper, zinc, lead, silver and iron from the Austin district. The same mineral-bearing solutions that deposited these metals apparently passed through sections of the marble, leaving behind trace amounts of a variety of metallic minerals that give the marble its array of colors.

The Whitehawk marble deposit is shaped like a bowl, with its outer northern and western edges forming a contact zone with the surrounding granodiorite country rock. The most intensely colored marble, and that with the greatest color variation, occurs at the contact zone, where the action of the mineralized hydrothermal solutions was greatest.

In 1998, two years after the discovery, Rose and Hulst began mining, processing and marketing their marble. In their surface mining operation, bulldozers blade away the shallow overburden, then backhoes remove the well-fractured, uppermost sections of the marble. Currently, most of the marble is sold for landscaping, decorative or artistic uses. To prepare landscaping rock, the marble is crushed and screened to 1 inch in size. Marble for artistic and decorative uses in mosaics, aquariums and planters is crushed to about ¾ inch in size. The sized marble is then tumbled in water in rotating drums, which range in capacity from 15-pound to 500-pound units. The tumbling action abrades the surface of each piece of marble to reveal its full brilliance and color.

The byproduct of tumbling is a substantial volume of 350-mesh granulated calcium carbonate, which is dried, sacked and sold to industrial processors. Processors then use a simple precipitation method to refine and convert the calcium carbonate into high-purity calcium chloride, which is valuable as a whitening agent for paints and papers, as a filler material in the manufacture of polyvinyl chloride (PVC) pipe, and in the preparation of cosmetics and pharmaceuticals, especially antacids.

In one section of the contact zone, black and white marble occur together. When such pieces are polished, the colors contrast with each other much like in Rose's opinion, the distinctive color combination of an Orca killer whale. That resemblance led to the Orca Line of the Whitehawk Material Co.'s marketing name for its varicolored marble. Whitehawk also has names for specific marble colors, which include "Candy Cane" and "Christmas" for red and white, "Pearl of the Mountain" for pure white, "Dalmatian" for white with black spots, "Desirae Rose" for solid red, and "Krista" (after Rose's blue-eyed 12-year-old daughter) for blue marble.

In June 2000, a customer's order for an unusual rust-colored marble led to yet another mineralogical surprise. To find that specific color, Hulst went to the contact zone, mined the required tonnage, and hauled it back to the crushing plant. He hosed it down quickly to loosen the surface dirt, then turned to another job. Returning later to inspect the material, Hulst was amazed to find minerals that didn't belong in a marble deposit—pieces of green malachite and bright blue azurite, some as heavy as 50 pounds, along with many smooth, rounded, golden "nuggets" of chalcopyrite.

Assays revealed that the chalcopyrite contained 28 percent copper, 4.4 troy ounces of silver per ton, and [illegible] troy ounce of gold per ton. The malachite contained 30 percent copper, 1.52 troy ounces of silver, and 0.05 troy ounces of gold per ton, along with small, but recoverable, amounts of platinum and palladium. At current metal prices, both the chalcopyrite and malachite are extraordinarily rich ores, each worth about $800 per ton.

What Hulst had discovered was a highly mineralized, vein-like structure, an "offshoot" of the main ore bodies of the Austin district that had been emplaced within the marble contact zone. Researching the local mining history, Rose found references to similar deposits. In the 1870s, Austin miners working near the marble contact zone had recovered $3 million in copper, silver, lead and iron. All of it had come from shallow shafts, none deeper than 200 feet, that exploited what the historical literature described as "large, irregular chambers or pipes" filled with high-grade ores.

"After we studied the history, we searched the surface of the contact zone," Rose explains. "And sure enough, we found the remains of old shafts where miners had mined several of those mineralized offshoots. Some are at least 20 feet wide and had been mined to a depth of 40 feet. The miners had obviously extracted a large volume of ore, yet we found no old heaps of waste rock at all. So everything they mined had to have been high-grade ore, which they probably shipped by rail to Anaconda, the smelting center for the Butte mines."

The offshoots are filled with many unusual mineral specimens. The malachite nodules cut easily and take a fine polish, while the composite pieces of bright blue azurite, green malachite and orange hematite make colorful display specimens. The gold-bearing chalcopyrite nodules can be cut and polished to a high luster. And well-developed clusters of 1-inch tabular calcite crystals also occur in the offshoots.

For Rose and Hulst, the Whitehawk Mineral Co. is a potential million-dollar-per-year business. They are already marketing their Orca varicolored marble in Montana, and are pursuing similar marketing opportunities in Canada and Japan.

The mineralized offshoots that Hulst recently discovered may be a bonanza. Geologists believe that offshoots exist throughout the contact zone, and that mining them could be profitable indeed. Ore extraction, either through surface mining methods or shallow shafts, would generate little or no waste rock, thus creating no surface-disposal problems. The Stillwater Mining Co., which operates the United States' only primary palladium-platinum mine at Columbus, Montana, has offered to process the high-grade ore on a toll basis. Rose and Hulst will hand-cob the ore when it is mined, retaining the best specimens and making them available to collectors.

"We'll mine marble and the offshoots for the next few years. But properly and fully developing an 80-million-ton marble deposit is simply beyond our capabilities," Rose admits. "So our long-term plans are to find a large mining company that has a good environmental track record, and the experience and resources to do the job right.

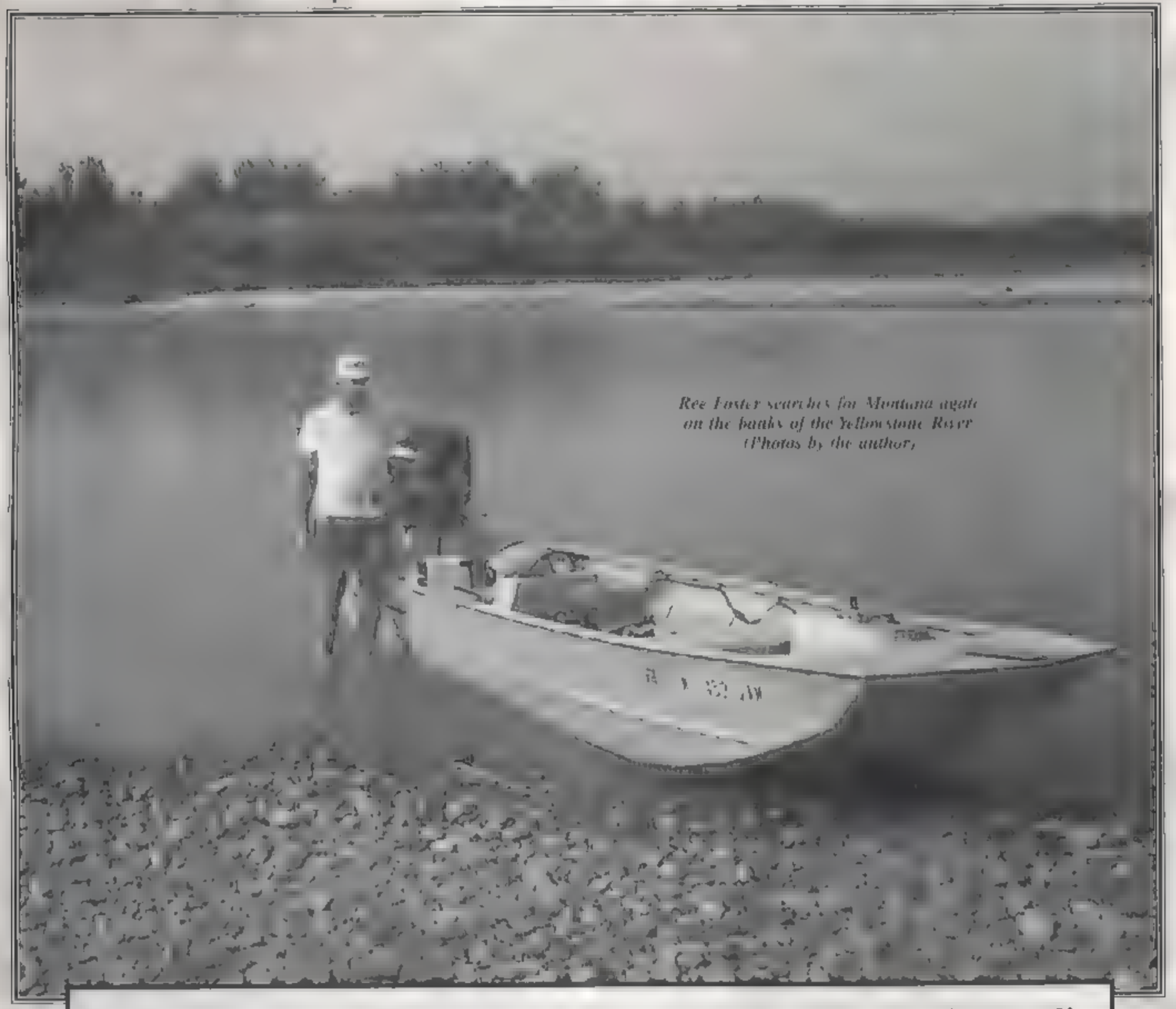
"We're still awed by all that's happened in the last few years," Rose continues. "We're just two rockhounds, and I can't believe what all this has turned into."

Do other rockhounds have a chance of making similar discoveries?

"Absolutely," Rose says emphatically. "The key is to keep an open mind, because you never really know what you might find. When we were looking for gold back in 1996, we certainly weren't thinking about marble. But we found something unusual, and we checked it out by using all the resources available to us—libraries, historical and mining literature, assay offices and labs, and the state bureau of mines. So, yes, I think any rockhound has a chance of doing what we did."

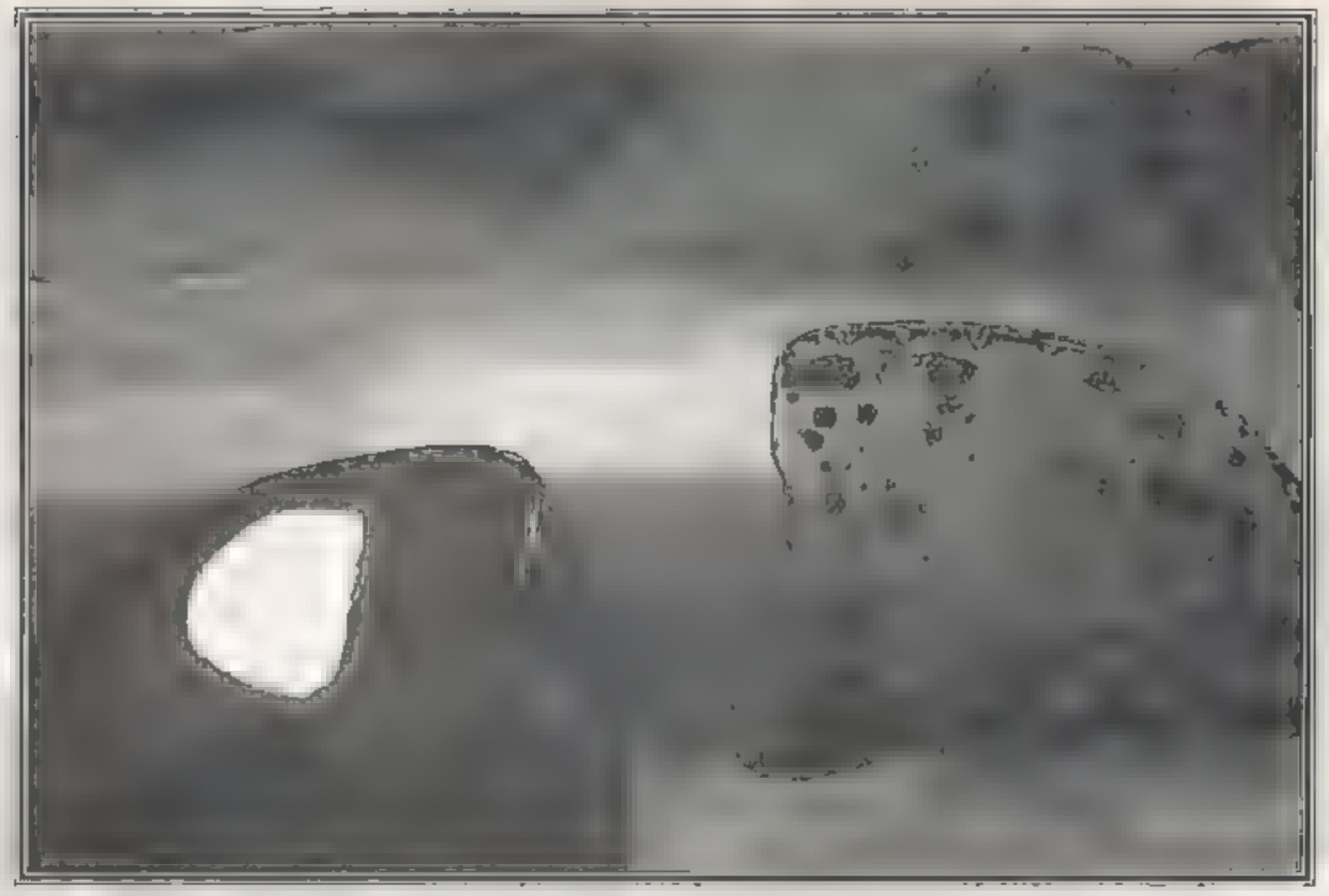
For further information about the Whitehawk Mineral Co., its marble, its unusual specimens of malachite, azurite and auriferous chalcopyrite, or the address of its coming Web site, contact Scott Rose at P.O. Box 1737, East Helena, MT 59635, or by e-mail at scott3196@ao.com.

Agate Picking in Montana

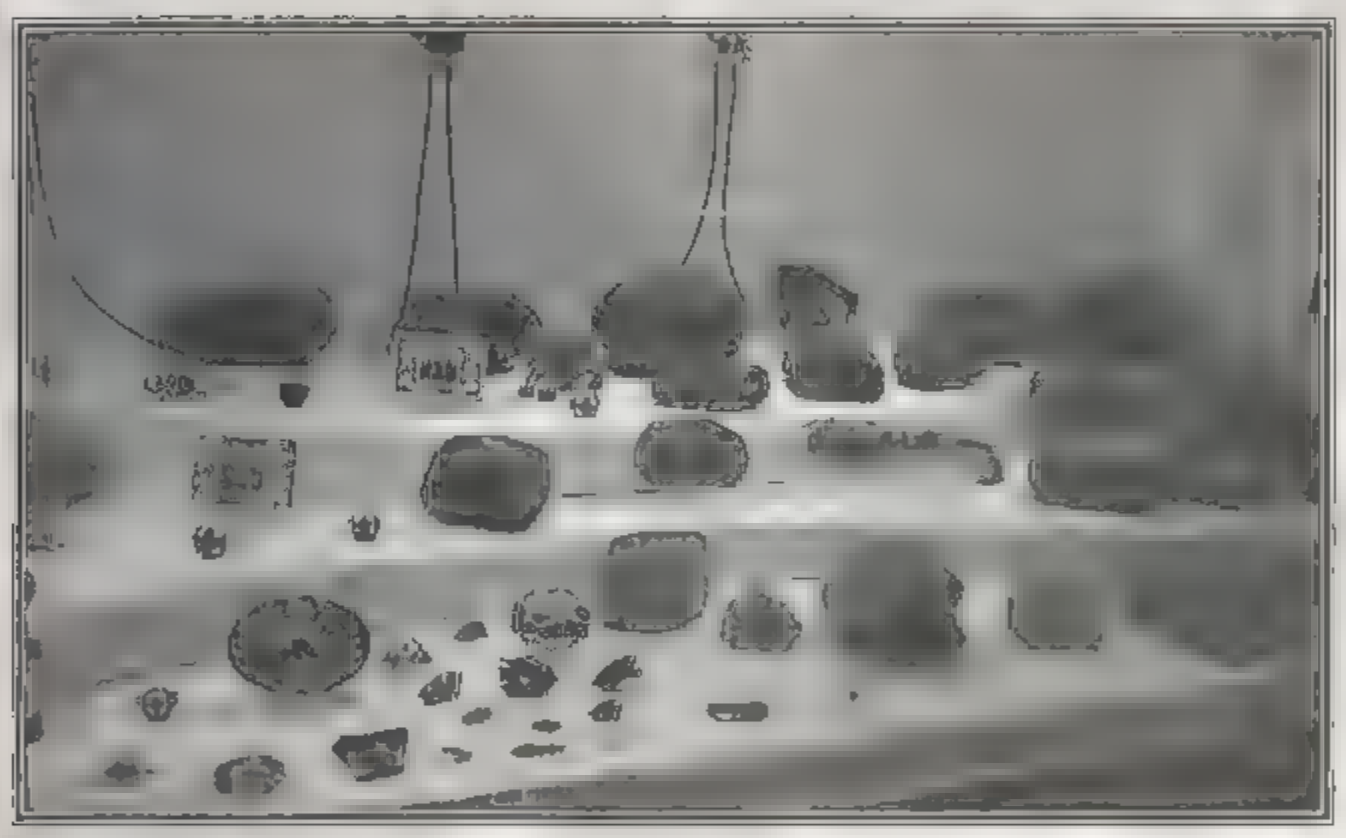


Ree Foster searches for Montana agate on the banks of the Yellowstone River (Photos by the author)

A Rockhound Goes in Search of His "Prize Stone"



Prize specimens of Montana agate from the Harmon collection. Red coloring is predominant in the agates found in the area from Sidney to Glendive, Montana



by Brooks Britt

I saw my first Montana agate almost 30 years ago, in a rock shop in the capital of my home state, Richmond, Virginia. It was a slab of swirling red and orange banding in clear agate, and when cut into a cabochon, it was my prize stone for many years. Intrigued with that stone, I wanted to learn all I could about where and how it was formed.

I located rock shops that dealt with Montana agate, and before long I had ordered finished stones from several of them. Paul Fry, the owner of Fry's Rock & Gem Shop in Miles City, Montana, had even published a book that explained just about everything dealing with Montana agates. I found it fascinating and informative. I was hooked!

Over the years, I did business with several other rock shops, but many had closed their doors for good, and getting quality Montana agate was becoming a problem. I think many of the old-time agate pickers have either retired or passed away, and the void hasn't been filled with new dealers. Fortunately, there is one dealer who has been in business for about 30 years, and because of his legacy of his son, Jim, his business will go on for many more years. I am referring to Tom Harmon, owner of Harmon's Agate & Silver. This fine establishment is a family affair. Tom's wife, Cheryl, Jim and Jim's wife, Deanna, are all active partners.

While I was in Las Vegas, Nevada, on business this past summer, I decided to finally realize my longtime dream of venturing to the Yellowstone River in search of Montana agate. After the conclusion of my business in Vegas, my friend and business associate Fred Bright, his wife, Joyce, and I rented a car to make the trek to Montana. Fred is also an avid rockhound, and was extremely excited about this trip. The first day we drove to Salt Lake City, Utah, the second day, to Cody, Wyoming, and the third day, to Sidney, Montana. This split the long drive into three manageable legs, leaving time to enjoy the sights. The trip proved to be everything we had imagined.

When we checked into our hotel in Sidney, there was a message at the desk that a Jim Harmon had already called to see if we had arrived. I immediately returned his call and received an invitation to meet the Harmons at their shop in Crane. They were in the process of moving their operation from Crane to Savage, Montana. They had bought an old diner and converted it into their new digs, The Agate Shop.

When we arrived at the shop, we were greeted by Tom and Jim. After dealing with him through the mail and with his son through e-mail for a number of years, it was indeed a pleasure. It wasn't long before we realized what a wonderful time awaited us over the next few days.

The first order of business was a guided tour of their shop. What "eye candy" awaited us! Case upon case of finished, top-quality Montana agate was for sale. There was also one large display case along the wall of some of the best of the best, which belonged to their private collection. This case in particular was a sight to behold. I couldn't hide my enthusiasm at getting this rare opportunity after all these years. Of course, before we left, I made several purchases for my collection. Each of their cabs is a rare treasure of superb quality, and their lapidary treatment is the best in the business. We made plans to meet at their new shop in Savage the next morning, eat breakfast there, and head for the Yellowstone River to look for our longtime goal, Montana agate.

When we arrived at The Agate Stop the next morning, there were several locals enjoying breakfast and coffee. Did I mention the Harmons also run a fine diner? Seems a lot of folks in this little town drop by to chat, eat breakfast, drink coffee, and talk agates. We also met one of Tom and Jim's friends, Ree Foster, a longtime agate picker. He was the one who was going to take us, in his boat.

continued on next page

Agate! *from page 35*

As Ree, Jim, Fred, Joyce and I headed down to the river, I was amazed at the terrain we had to navigate to reach the area where we could launch the boat. All of this land is privately owned, and permission from the owner is required to pass through it. Of course, the old-time agate pickers know the local farmers well and have long-standing agreements.

Once we launched the boat, we headed to several sand bars and coastal gravel bars where Ree and the Harmons have enjoyed success in the past. We received a quick lesson from Jim on how to spot the agates. That is easier said than done. The agates are covered by a light coating of dirt, and it takes a good eye and experience to pick them out from the gravels. The key is the texture and shape of the agate exteriors. Along the water, they can also be spotted because the transparent agate is easily discerned from the opaque gravels. There is also some fine red jasper and petrified wood that is abundant in the gravels. I had to pick up some of this material as well, because it was really gorgeous, solid material.

Of course, we had come for Montana agate, and Montana agate we found. We each picked up a number of pieces that obviously had color inside. Others didn't seem to have any color at all, but we were advised to check them out better once we got back to the shop. Some of the better layer agates that produce the sunburst and dendrite sprays may not look like anything from the outside, but once the material is slabbed, the beautiful red sprays appear. I also found out the pros can stay out on the river all day, but we tenderfoots seem to tire after several hours. I slept well that night!

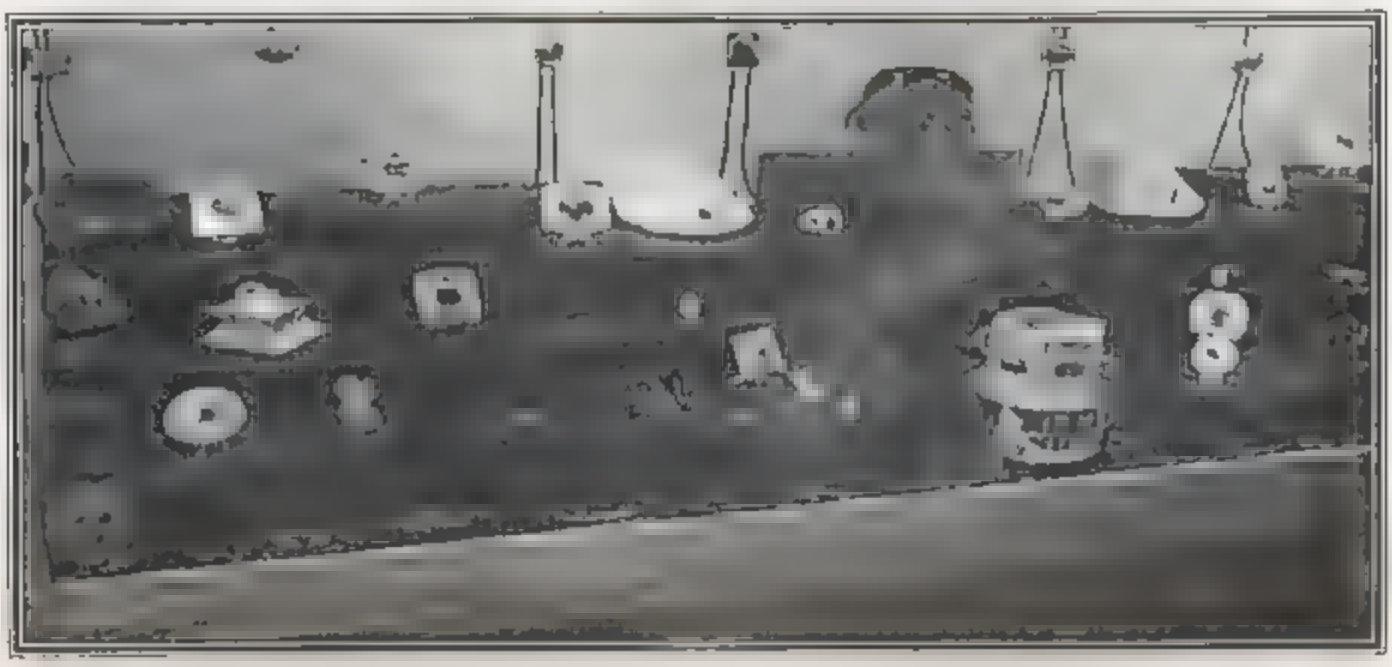
After we collected our booty, we headed back to the boat launch, and from there to The Agate Stop for lunch and a nice cold drink. We went back to the shop in Crane that afternoon, where I made several purchases, and Jim told me another of my Internet buddies, Jeff Nesper, was coming by to meet us. Jeff is another local agate picker who has a real passion for this rock. We sat around the shop and talked for what seemed like hours. Jeff had brought some of his recent finds with him, and Jim showed us how to "candle" the rough nodules. He uses a high-intensity lamp and wets the stones in the sink. In many of the rocks, you can see the dendrite sprays, and in others the bright red banding. I understand that the red coloring is predominant in the agates found in the area from Sidney to Glendive. Jeff invited us to another day on the river in an area where he'd had recent success. We planned to meet at The Agate Stop the next morning.

We again had permission from a local landowner to access the river through his land, but this time we walked to the area instead of using a boat. When we reached the river, there was an unbelievable area of agate-bearing gravels along the river, literally covering a mile. We had a little more trouble picking out agates because of the muddy covering, but Jeff didn't miss a beat. We would be walking along talking, and presto, he would reach down and pull one out. When we got back to The Agate Stop, Jeff really made my day by giving me all of his day's findings. There were several really promising pieces. One beauty that I had found was a gorgeous red-orange inside, and I left it with Jim to process. I hope to get several slabs from this rock, because it looked solid and colorful. You never know until you start cutting, though.

The day was another special experience, and to top it off, Jeff came by our hotel and showed us some really fine museum-quality Montana agates that he had collected and processed. Each would be a showstopper in any display, and Jeff was obviously proud of his finds. What a day! Unfortunately, we had to head back in the morning, so we planned to meet at The Agate Stop the next morning for breakfast before we headed out of town.

After breakfast, I made a few more purchases of gifts. We bade farewell to Jeff and the Harmons and headed back to Las Vegas and home, but I couldn't help reflecting over those few days. It is a trip I will long remember because of the fine people we met and the beauty of this land they call home.

The Agate Stop in Savage, Montana, has a wide variety of items made from local agate.



DISCOVERING A

Learning Intarsia, Part II

by Conrad Grundke

In Part I (March 2001 *Rock & Gem*, page 40), the preparation and assembly techniques for making the Mountain Retreat intarsia were explained. By applying those tips and techniques and using the tips on epoxying in this part, we can now begin construction of the intarsia itself. A beginner can expect to take a month to complete this project once the stones have been selected. With experience, this can be cut down to less than two weeks.

Epoxying

Except when making jewelry intarsias, I do not use "super glues." Their set up times are far too short. I join at least 98 percent of all my seams using Devcon 5 Minute Epoxy, which allows me to continue working on the piece within 10 to 15 minutes. This is one of the few clear epoxies that do not yellow when they dry and are strong enough to hold an entire picture together. When I have several large assemblies to glue together, usually the last step in completing the picture, I will use a 330 epoxy. This gives me a bit more time to get the pieces aligned before the epoxy sets up.

Only glue two pieces together at a time, if possible. Trying to glue more pieces simultaneously is difficult, and can present problems.

Glue the pieces together facedown on two layers of wax paper placed on the layout board. Being frugal here and using only one

LOST ART FORM

piece of wax paper will result in the front of a beautiful intarsia being glued to a layout board.

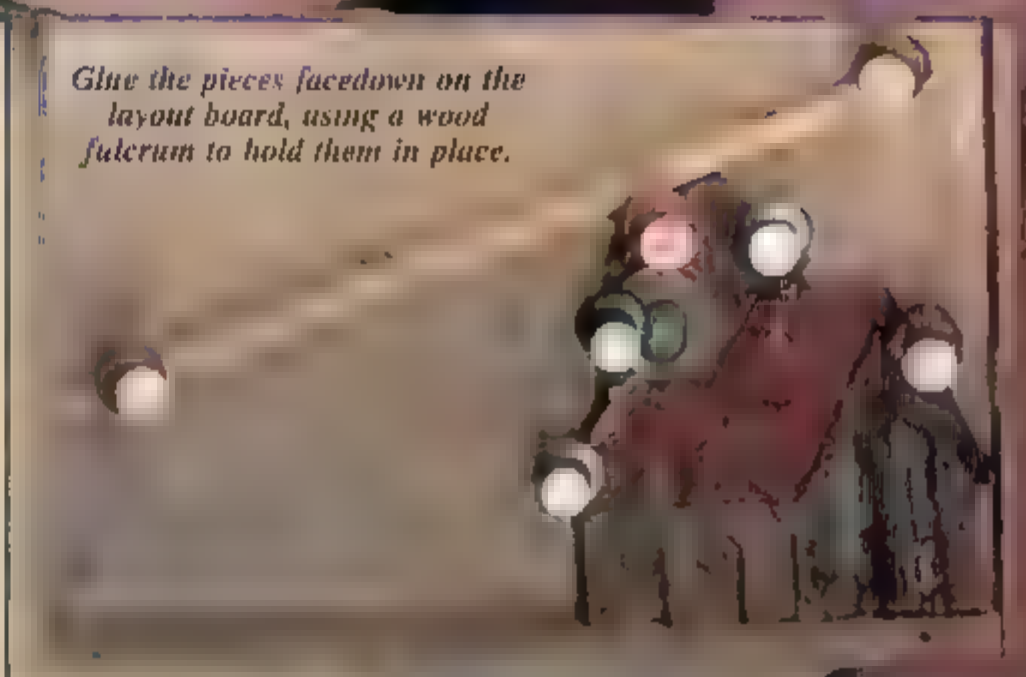
In the past, intarsia artists have used several methods to hide the fit in a seam that was not quite adequate. Crushing rock from one of the stones being glued in a mortar and pestle and adding it to the epoxy usually resulted in a tricolor intarsia: one color for each of the two stones, and a third for the epoxy. Mixing a pigment with the epoxy introduced a foreign substance that didn't agree with the epoxy, which would not harden and remained rubbery. I strive not to have seams that need to be aided in this manner. I have, however, added 80 mesh colored enameling frit to my epoxy to color it for seams that I want to bring out, like the lap between boards in a barn. The frit does not effect the hardening of the epoxy, and actually increases its strength.

I mix my two-part epoxy on an extra slab of stone. If I want it to set up faster than normal, I'll warm the slab under a heat lamp before I mix the epoxy. My preferred tool for mixing the two parts of the epoxy is an artist's palette knife. This minimizes the generation of air bubbles within the epoxy, and ensures a thorough mixing. There are a number of factors that can contribute to the epoxy not hardening and remaining rubbery, such as moisture, humidity, foreign substances like oil, and inadequate mixing of the two parts.

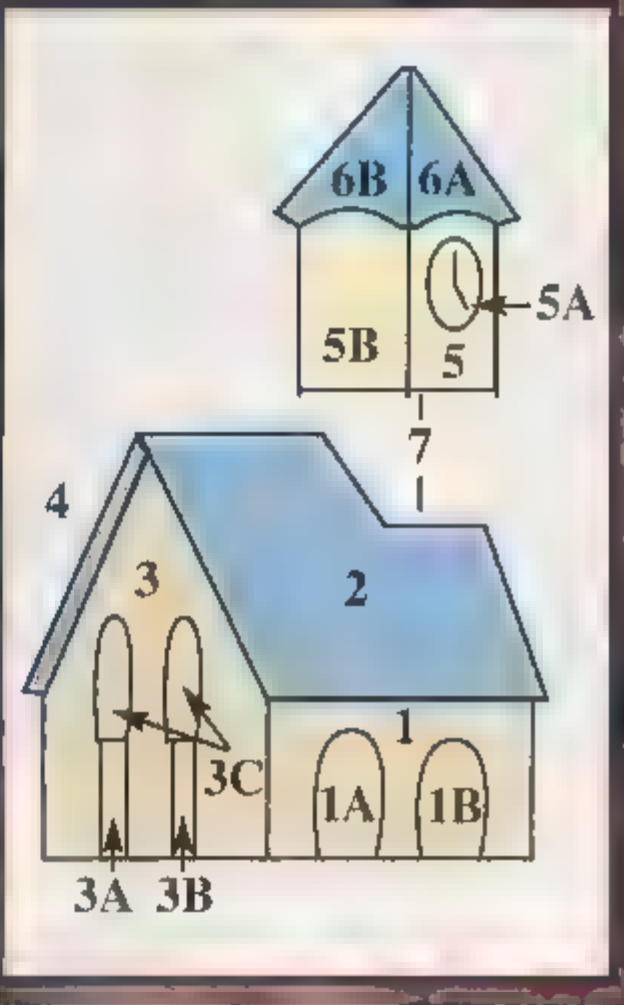
When gluing two pieces together, take up some of the epoxy on a finger and wipe it onto the edges of the two stones to be glued. Then apply additional epoxy with the palette knife.

Placing the two pieces facedown on the wax paper-covered layout board, push one side up against the raised-edge corner of the board. Hold the stones onto the board with steel pashpins. If you need to apply pressure to force the two stones together, you can use small strips of wood (similar to a square chopstick) as fulcrums to apply a constant pressure against one piece. Pashpins can help hold the fulcrum against the stone.

After gluing two pieces together, always lap the front surface flat on a lap wheel. This will ensure that, when you have assembled a whole picture, you do not find a small section that is recessed and have to lap the entire picture down.



Glue the pieces facedown on the layout board, using a wood fulcrum to hold them in place.



Church Building Assembly Process

In the assembly drawings, the pieces labeled 1a and 1b should be assembled into unit 1 before being attached to unit 2.

Begin by making the church as a separate assembly. The tip of the church steeple will be put into the sky as the last step before gluing the sky in place.

Draw the slots and outline of piece 1 on the stone selected for the sunny church wall. Cut slot 1a into piece 1. Cut a piece of mother of pearl or abalone shell to fit, and insert it into this slot. Epoxy the window in place. Then cut the second slot, 1b, and insert another window. If you try to save time by cutting both slots in a soft stone at once, it is possible that the piece between the slots will break out. These slots can be cut with a "nibbling saw" (described in Part I), a diamond-coated wire in a jeweler's saw, or a band saw.

Cut the left and bottom edges of piece 2, and epoxy pieces 1 and 2 together. Leave the bottom of piece 1 extending beyond what is needed for the finished piece. It will be cut off later when you fit it to the wall (piece 11).

Lap the front surface flat. I use a 24-inch cast-iron lap and 220 grit. Anyone who does not have access to a lap of this size can use an 18-inch-square piece of plate glass and manually lap the piece using 220 silicon carbide grit. Place the grit and some water on the glass and move the intarsia back and forth over it to grind down the surface. It requires a bit more work, but is a feasible alternative.

Assemble 3a, 3b and 3c in like manner, then fit and epoxy assemblies 1, 2 and 3 together. Add the roof strip 4, then lap the front surface flat.

The church steeple is assembled next. Create the clock with the hour and minute hand as an assembly 5a. Cut slots in the clock face material for the hour and minute hands with a jeweler's saw, and inlay black stone. Cut out the clock face. A small nailhead can serve as a dop stick when cutting out the face. Drill a small hole 1/8-inch into the sunny steeple wall material. Enlarge it to the oval shape of the clock face. Fit the clock face into this oval opening and epoxy it in place.

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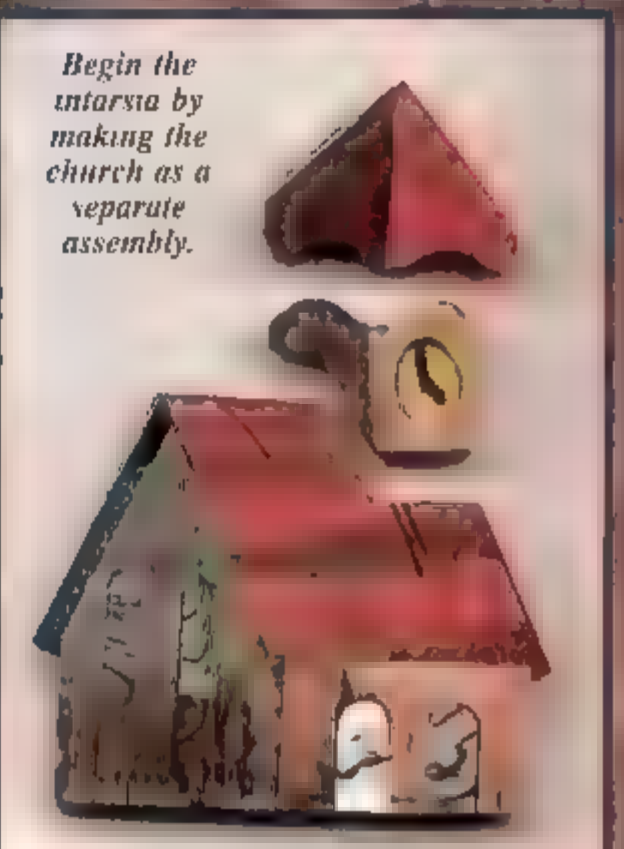
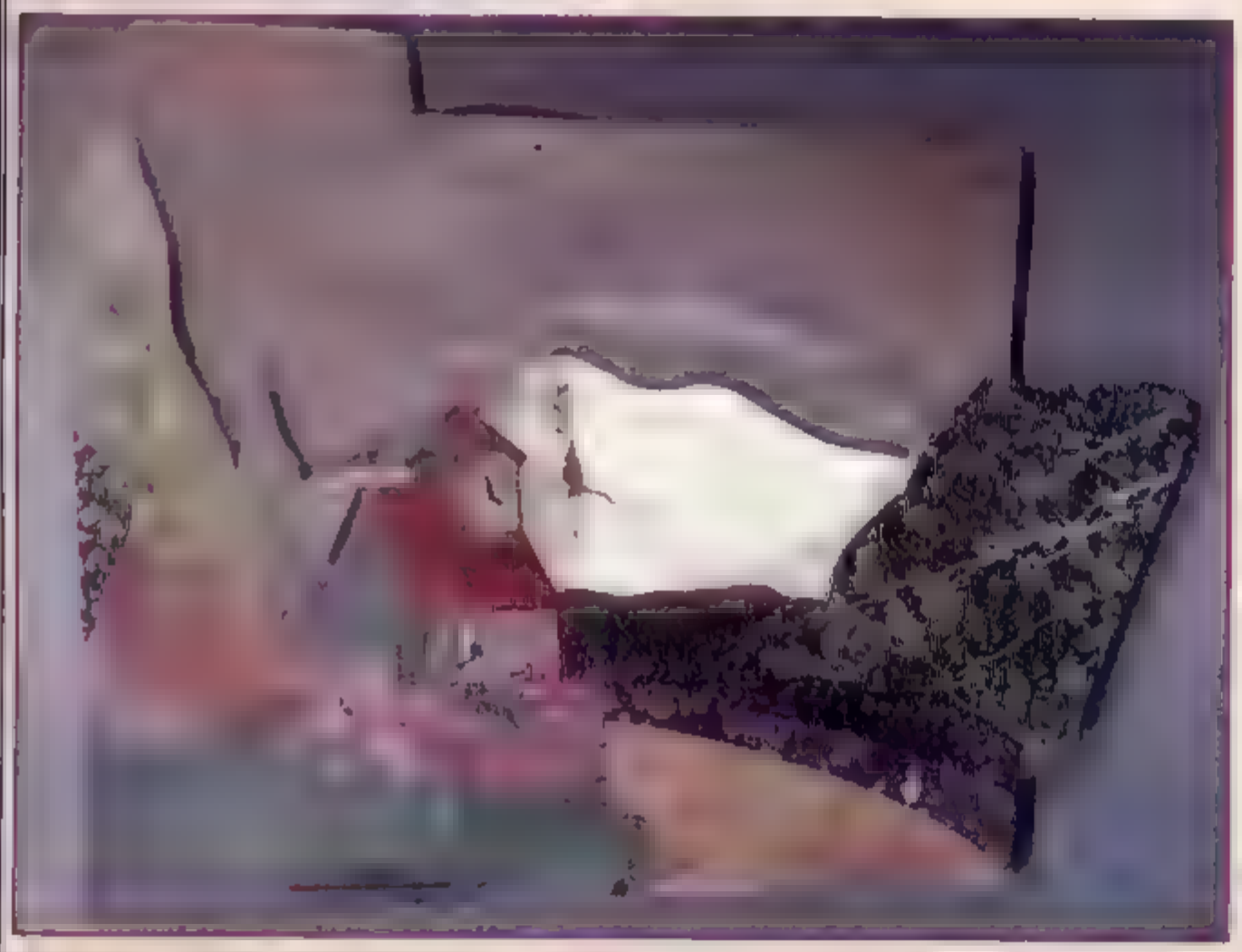


Begin the intarsia by making the church as a separate assembly.

Lost Art Form/ *from page 41*

Fit and epoxy parts 5, 5a and 5b together. After this is done, cut the top two arched surfaces to the desired shapes. Fit and epoxy 6a and 6b together. Fit assemblies 5 and 6 together and epoxy. After the epoxy has set up, grind the top of the steeple roof to the desired shape. The steeple is then ready to be fit and epoxied onto the church body to complete that assembly.

The final outer edge of the picture will be trimmed down once the entire assembly is completed.



Epoxy strips of brass around the edges of the picture to form a border, and fix four machine screws to the back for mounting.

Once again, lap the front surface flat.

Assembly Process Concluded

Once the church building has been completed, the remaining pieces of the picture can be fit and epoxied together, one at a time. (See Part I for the assembly sequence.) When fitting the next sequential section, only cut the sides of the piece that will be epoxied to the existing assembly. Remember to lap the front surface after each new piece is added.

As you add pieces 10 through 14, do not cut the edge of the picture at this time. The final outer edge of the picture will be trimmed down once the entire assembly is completed.

When you reach sections 17 and 17a, this can be created using two separate stones fit and epoxied together, or if you can find a stone with the necessary pattern, this can be created out of one piece. This area of the picture represents some bushes or trees (17) with some flowers or blossoms on the top (17a).

In this picture it is helpful to find a rock that will imitate a rock wall for section 16. This can be difficult to find. Some stones to consider are brecciated jasper (as was used in this picture), petrified dinosaur bone, turritella and petrified palm root, cut at an angle.

Section 21 will be the longest length you will have to fit. This will be a major challenge, since there will be times when you will grind too much in one area, affecting the fit in another. I used a thin section of soft marble for the sky. In the process of fitting piece 21 into pieces 10 and 12, a piece of the sky broke off. Normally, I would have cut another piece; however, this was the only piece of marble I had, and as a means of salvaging the piece, I inserted a tree between pieces 12 and 10.

Fit piece 21 to the lower assembly, but do not epoxy. Next, cut the slot for 21a out of 21 and insert the steeple into the sky. Once assembled, 21 and 21a can be epoxied to the lower sections as a single unit. This sequence will ensure proper alignment between the steeple top and the steeple roof.

Once the picture has received its final lapping with 220 silicon carbide grit, the outer edges can be marked and trimmed off using a thin-kerf diamond trim saw blade. I then finish the edges with an 8-inch diamond grinding wheel, being careful to not let the edge of the wheel cut into the edge of the picture. Gentle pressure and a slight left-and-right motion across the wheel surface can effectively trim the edges to their final dimension.

Finishing Your Intarsia

Epoxying strips of brass around the outside to form a border will hide the outside edges of the intarsia. I use a mitre fit at the corners, but you can make it easier by using a square box fit.

Once the brass is epoxied to the edges, I use a sanding drum with 220 paper to remove any brass edging that protrudes above the top surface of the picture. Use plenty of water when grinding down the brass, otherwise the excess heat will break down the epoxy holding the brass to the stone. I use ¼-inch by ⅛-inch brass binding.

Lap the entire surface of the picture using a 600 sanding drum or sanding block with 600 sandpaper.

Epoxy the head of a brass 10-24 by ½-inch flathead machine screw to the back of the intarsia at each of the four corners, approximately ½ inches in from the edge.

Select a piece of masonite (or pressed board) a bit larger than the final size desired for the completed and framed picture. Place the picture in the center of the masonite and mark the location where each machine screw makes contact with it. I do this by applying a slight drop of fingernail polish on the end of each screw, which will leave a mark where it touches the masonite. You may have to rock the picture to get each screw to contact. Then drill holes large enough to accommodate the machine screws through each mark. With the screws in place through the holes, measure and mark the distance desired as a border from each side of the picture, and cut the masonite to this final size. For a picture of this size, I will allow approximately 1 to 2 inches on each side.

A background of dark felt makes the picture look as though it is floating in the frame, creating a shadow box effect. Take your picture to a fabric store and by laying the picture on the various shades of felt, select the one that best brings out the colors in the intarsia.

Coat the masonite with a spray adhesive, and gently stretch the felt over it. After the adhesive is dry, trim off the excess felt.

Mount the intarsia on the masonite with nuts that fit the screws, and take your work of art to a reputable framing shop. The last place you want to cut costs is in the frame. It will add immeasurably to the picture's final appearance. Most of my frames cost between $75 and $100, but it is worth adding this much to a $1,000 to $5,000 work of art.

Once you have completed your first intarsia, you will be hooked. Where else can you find a work of art like this outside of a museum? Even the Smithsonian does not have pictures to compare to the pieces of rock art that too frequently get displayed at American Federation of Mineralogical Society lapidary shows. I'll look forward to seeing your work at one of the shows in the future, and having the opportunity to meet you and share our methods and techniques.

You can contact Conrad Connie Grundke at 2214 B Via Mariposa E., Laguna Woods, CA 92653, (949) 837-0948, email: cgrundke@pacbell.net.

Sideling Hill's Geological Secret

The south side of Sideling Hill shows a distinct thrust fault at the bottom of the coaly shale layer near the third berm (Photos by the author)

Exposing a Syncline in a Maryland Road Cut

by Dorothy S. Sites

I've been privileged to enjoy an unforgettable literal mountaintop experience scaling the summit of Sideling Hill with Dale Shelton of the Maryland State Geological Survey and several other visitors. I'd previously visited the first berm of the outcrop with geologist Ken Schwarz as he instructed a group of college geology students. I'd taken pictures and rock specimens, and listened carefully, meanwhile looking longingly several hundred feet higher to the summit I'd not climb that day.

When Dale invited me along, "no" was definitely absent vocabulary. For this maturing rockhound, the climb up the cut's south side was exhausting. Occasional breathers and hangings-on to locust saplings and protruding roots helped conquer the loose shale underfoot, and I made it. From my vantage point, the vehicles traveling the interstate far below us were reduced to miniatures, and the Exhibit Center was a beige pyramidal matchbox.

We scrambled over huge Purslane sandstone boulders and through viny undergrowth. If any rattlesnakes were present, they chose to ignore us as we clambered for about one-tenth mile along the ridgetop to photograph the crown stone, marker No. 37. The historic stone was

The sheen of green, blue, violet and purple on black shale gives "peacock rock" its name (above). Dark gray and black marine shale from the Mississippian-Rockwell (Kenderhookian) deposition is visible just below the railing and stairway (right). This is the nation's only road cut with a geologic museum attached (below).

placed there in 1765 by Charles Mason and Jeremiah Dixon during their 1763-67 survey, which established the boundary line between Pennsylvania and Maryland.

This exhilarating capstone of years of rockhounding has enhanced my in-depth study of the Sideling Hill syncline and has been the catalyst for this discussion of its geology and Exhibit Center.

All devout rockhounds automatically brake for outcrops. At this spot along Interstate 68, six miles west of Hancock, Maryland, you are welcome to stop and visit the most spectacular synchine east of the Mississippi River, distinctly unique as the nation's only road-cut with a geologic museum attached.

Had not the perennially dangerous hairpin curve on Maryland's Scenic Route 40 (a National Road) at Sideling Hill's summit caused numerous traffic fatalities in mountain fog, ice, snow and rain, its safer and faster parallel, I-68, a mile and a half to the north, would not have been constructed. The awesome syncline would have remained shrouded beneath the Western Maryland forest, retaining its 340 million year-old unearthed splendor.

continued on next page

Sideling Hills/ *from page 49*

Before the Holloway Construction Co. of Wixom, Michigan, began blasting and slicing at Sideling Hill in April 1983, the Maryland State Department of Highways took many core samples. The drilling evidenced quartz conglomerate capstone harder than steel and relatively softer underlying shales, mudstones, siltstones and sandstones. The multicolored and multitextured samples merely hinted at the breathtaking size and beauty of the syncline itself, exposed on the north and south sides of the completed highway cut. The new road was finished and opened to traffic following 16 months of blasting, and construction continued until August 1985.

The Holloway Co. excavated about 10 million tons of rock, crushing and sizing it on site to grade the eastern and western approaches to the cut. The construction crew arrived with brand new Caterpillar road-building machinery to minimize delay caused by broken equipment. Sixteen nonstop months later, the Purslane resistance had greatly worn down the excavating machinery. To blast the bedrock and downsize huge boulders, they used 5,200,000 pounds of explosives. The cut cost $20 million, compared with $ 41 million for the approximately 40 mile section of I-68 between Hancock and Cumberland, Maryland. The cut is 720 feet wide and 340 feet deep from the topmost exposed rock to the paved road surface.

In the original plans, a tunnel, not an open roadcut, would have been built. Tunneling plans were abandoned, however, after it was decided that construction and maintenance costs would be prohibitive. The prospective tunnel would have required a year-round, 24 hour standby heavy duty wrecker truck, as well as lighting and ventilation maintenance. Had Sideling Hill been tunneled through, the syncline would not have been exposed.

The new interstate rapidly replaced old state Route 40 as the best route east and west over the mountains of Washington, Allegany and Garrett counties in Maryland. Its terminus is in Morgantown, West Virginia. It reduced travel time, proved much safer and afforded wonderful scenery. The roadcut at Sideling Hill has facilitated vast improvement but had inadvertently created a new problem. Many motorists — not only rockhounds, but the general public — stopped along the highway for a closer look at the cut. They created traffic hazards and the potential for rock slides in their attempts to scale the outcrop.

Some exploration-bent souls were deterred by No Rock Climbing, No Stopping, No Trespassing, and other signs, but not all. Dr. Kennett Weaver, then state geologist for Maryland State Geological Survey, recognized the syncline's significant potential as a model for geologic studies and as an educational attraction for the general public. A newly [illegible] architecturally designed to blend with synclinal colors and contour would be a combined rest stop, travel information source, and geological classroom and museum.

Maryland State Senator Victor Cushwa was highly instrumental in securing the $4 million state funding for the Exhibit Center, two parking areas, and the pedestrian bridge across I-68. Officially opened to the public August 2, 1991, the Exhibit Center receives financial support from Maryland's Department of Natural Resources, DNR, Department of Transportation, and Department of Economic Development, Bureau of Tourism.

The presence of the syncline and the awesome view of ridges and valleys covering 40 miles of the states of Maryland, Pennsylvania and West Virginia make Sideling Hill Exhibit Center unique as one of Maryland's state parks. Department of Natural Resources rangers supervise its operation and maintenance. The Department of Transportation staffs the center with a representative to oversee highway related concerns, and state troopers routinely monitor both parking areas. The Bureau of Tourism oversees the selection and free distribution of maps and other travel literature. The smoke free and handicapped-accessible facility is open daily from 9 a.m. until 5 p.m. except for major holidays.

No general hiking trails are open on either side of the cut; trespassers are subject to prosecution. The cut rises 340 feet above the heavily traveled highway. Pencil shale and other loose rocks, but their gravitational descent on the four 20 foot wide horizontal benches (berms), placed 80 feet apart from road base to summit. The benches help prevent rock slides from impeding interstate traffic, but they were never intended to protect climbers from falls. All nonstaff persons visiting the outcrop must be accompanied by a geologist or DNR ranger. The visitor must schedule in advance, wear a hardhat, and sign a waiver in case of injury while on the outcrop. Visitors may, however, climb the wooden steps to the base of the south side outcrop as far as the locked gate. Forest residents worthy of caution include black bears, rattlesnakes and copperheads.

What a geological banquet this syncline serves! Located in the foothills of the Allegheny Mountains, in the Ridge and Valley Province of the Appalachians, it is plate tectonics visualized. It resulted from the rippling, faulting and folding during the mountain building Appalachian Orogeny, which followed the collision of the North American and African continents. Sideling Hill's syncline is the slowly eroding remnant of sedimentary layers deposited 315 to 325 million years ago.

Nearby Town Hill, to the west, and Sleepy Creek Mountain, to the southeast in West Virginia, are sister synclines with sim-

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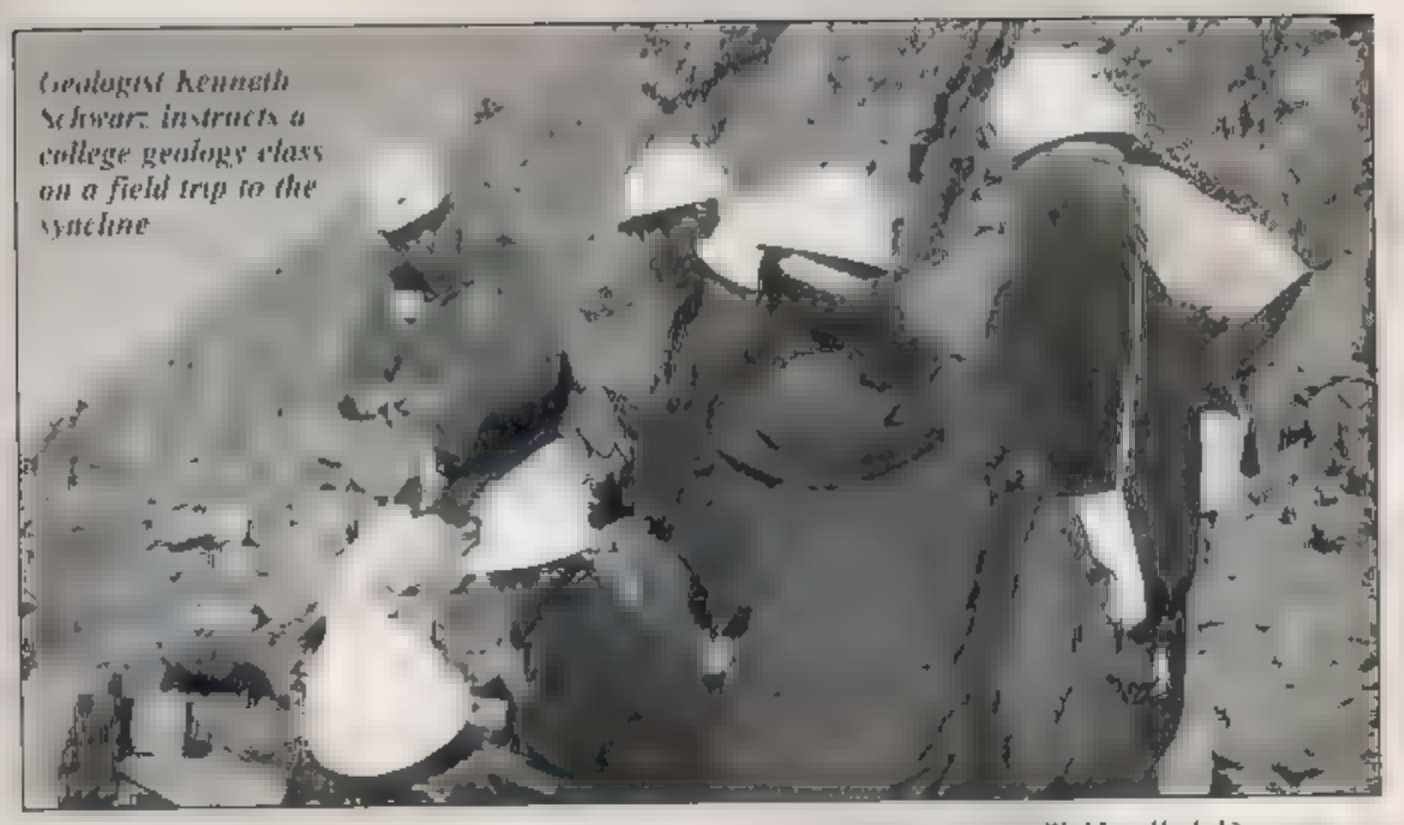

Geologist Kenneth Schwarz instructs a college geology class on a field trip to the syncline

Sideling Hills/ *from page 50*

dar rock types. The reverse-patterned (layering) sedimentary anticlines that lie between are partial depositories of less resistant rocks carried by erosional forces into their valleys, and beyond them, to the eastern coastal plain.

Some synclinal structures have surrendered to erosion, but Sideling Hill remains. Why? Geologists believe that Sideling Hill was once 10,000 feet higher than its present 1,520 feet above sea level. The total structure might well have already joined its sedimentary partners in their eastward disintegration, had not these Mississippian-period Paleozoic rocks been preserved by the extremely hard Purslane Formation quartz. The Purslane, younger than the underlying Rockwell Formation, has acted as a shield, keeping water from percolating through to the rocks beneath it.

Sideling Hill's oldest (Rockwell) deposits were initially marine, from a broad, shallow sea that covered most of central North America about 355 million years ago. As rainwater propelled increasingly enormous volumes of mud, silt and sand westward from mountains east of Baltimore, deposits built up and eventually filled in the sea's central Maryland shoreline. The seashore then shifted to far-western Maryland and to nearby West Virginia. Varying layers of sedimentary thicknesses resulted from the sea's back-and-forth shifts. As the sea receded, thick terrestrial (regressive) deposits displaced the marine sediments.

The dark gray to blackish color of the shale based Mississippian Kinderhookian strata on both sides of the cut just west of the connecting Victor Cushwa pedestrian bridge exhibits evidence that these sediments formed once in an oxygen-deficient environment, and that and ferrous oxide colored them. Marine fossils found in this layering include the remains of clams, snails, brachiopods and fish. Plant fossils are also abundant in Purslane layers here.

A visitor recently asked, "Did the construction crew find any dinosaur skeletons or human arms and legs when they blasted the mountain away?" Hardly! Dinosaurs didn't exist until approximately 220 to 67 million years ago, during the Triassic and Cretaceous periods of the Mesozoic Era. As we've seen, the Sideling Hill sediments belong to the much earlier Paleozoic Era, while humankind debuted approximately 10 million years ago.

A highly visible layer of black coaly shale in the Purslane Formation, several layers below the capstone boulders, testifies to the pressures of rock layers that were once perhaps 10,000 feet high. Formed in a swamp environment, the shale's fossils exhibit plant stems and bark, including ferns. While not sufficiently thick for commercial mining, it's the easternmost known coal deposit in western Maryland. This layer incorporates an approximate 4- to 8-inch seam of semianthracite coal. Carboniferous formations result from pressure upon decaying plant life in swamplike conditions.

Of particular geologic interest are the rocks and minerals at Sideling Hill: bronze mica, pyrite, "peacock rock," limonite, siderite, quartz crystals and diamictite. Mica among sedimentary rocks? There was no volcanic activity in the area's geologic past, it was apparently wind-carried from the east, where igneous and metamorphic rocks do exist. Frederick County to the east is the source of the 1.1 billion year-old igneous granite gneiss block in the Exhibit Center, billed as Mary and's oldest rock type exposed at the surface. Greenstone, a metamorphosed volcanic rock, is found at South Mountain.

Pyrite occurs most frequently as fragments scattered among rocks of the cut and occasionally as larger cubes in the black shale and other rocks. A large specimen is part of the geologic museum's exhibits. The iron hydrate mixes with ferrous oxide to help produce the bright reddish, orange, yellow, and rust-brown surface coloration on the south cut. Decomposed pyrite also imparts acidity to the aquifers, which are visible on both sides of the cut.

Both goethite, a secondary iron mineral commonly associated with quartz, and siderite, an iron carbonate, are found here, as is "peacock rock." The eye catching sheen of green, blue, violet and purple on the surface of black shale gives the rock its name. Quartz crystals here are usually small, in surface crustings or in rock veins and cavities, coloration is clear to translucent, opaque, white to gray or light yellow.

What is diamictite, a rock with igneous and metamorphic particles, doing among the syncline's Rockwell Formation sedimentaries? It has assorted clay, silt, sand and cobbles from unknown sources. A similar sandy to salty diamictite occurs at Ransom near Wilkes-Barre, several hundred miles away to the north in Pennsylvania's anthracite coal region. Some geologists who have studied and measured layers believe diamictite's igneous and metamorphic fragments are the remains of a huge crater formed by a catastrophic meteoric impact – the same type of event as that responsible for the formation of the Chesapeake Bay.

A collector may have difficulty obtaining specimens at the syncline roadcut unless authorized by and/or in the company of a geologist or ranger. A viable alternative lies along Sideling Hill's summit on Scenic Route 40, along the roadcut at the infamous hairpin curve. There's room to pull your vehicle off the road so you can "access" Sideling Hill rocks and even some fossils.

Inside the Exhibit Center, the time spiral illustrates the geologic history of site from 3.5 billion years ago to the present. The museum exhibits geology basics, including the three types of rocks, conglomerates, crystallization, slickensides, ripple marks, crossbedding, plant fossils, and essential geological tools. Murals illustrate the syncline's formation and layering. A floor to ceiling color photographic display matches core samples with their respective sources in the syncline just outside.

A Synthetic Aperture Reader Imagery (SAR) system shows the individual viewer "from the top" images of valley and ridge topography, and a continuously-playing video explains how the Appalachians and Sideling Hill were formed. A polarized microscope lets the visitor view crystalline intermeshing inside a slice of rock thinner than a human hair. Other educational facilities include a brief construction history video and transportation game.

Thousands of visitors stop to see the syncline for themselves, and so must you. To schedule a group tour of the Exhibit Center and/or outcrop, or to learn more, write to Fort Frederick State Park, 11,100 Fort Frederick Road, Big Pool, MD 21,722, or call (301) 842-2155. To reach the Exhibit Center and syncline, follow Interstate 70 from the north and east to Hancock, Maryland. from the south, take state Route 522 north to Hancock. From the west, take I-68 from Morgantown, Frostburg, Cumberland, or other points of access. I-68 joins with I-70 E-W at Hancock. ❀

Rockhounding in Berber Country

A Wealth of Minerals for the Picking in Morocco

by Bob Farrar

Like many of you who are reading this, I have gone to more gem and mineral shows over the years than I can count, and looked at more mineral specimens than I can shake a stick at. Some I have drooled over, others I have passed over with little thought, and a few I have purchased. Among the specimens I have drooled over, and occasionally purchased, have been an extraordinary number of fine minerals from Morocco: vanadinite, smithsonite, azurite, cerussite, anglesite; the list goes on and on. Certainly, Morocco ranks among the great source countries for fine minerals. But, compared to some of the other great mineral countries, such as Brazil and Mexico, not much has been written on the mineral localities of Morocco, at least not in nontechnical English and in publications that the average rockhound has access to.

Those who are interested strictly in gemstones will be disappointed with Morocco. There is a little quartz and amethyst, but the crystals are usually too

Agates (right), 3 inches and smaller, collected at Agoum in the High Atlas Mountains of Morocco. The ghost town of Aouli (below) was once the center of a lead mining industry. (Photos by the author)

Secondary copper minerals azurite and malachite, found near Aouli.

small to cut. There is some nice agate, but the Moroccans don't seem to exploit it as much as they could. Otherwise, there is only a bit of amazonite and perhaps a few other stones of minor significance. For gemstones, go someplace like Brazil. But for mineral specimens, Morocco will not disappoint.

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Rockhounding/ *from page 53*

Interesting minerals are found in a variety of geological environments in Morocco, but there are perhaps two main types of deposits of interest to collectors. The first is basaltic lava formations of Jurassic age, which contain agates and geodes. These formations are concentrated just east and south of Marrakech, in the High Atlas Mountains. The other, and by far the most important type, is metallic ore vein deposits. These deposits seem to be found all over the country, but are best developed in the areas of Mibladene, Taouz, Touissit and Ouarzazate.

On our tour, my wife, Lisa, and I were guided by a Moroccan named Adam Aaronson. The first mineral locality that we visited was in the basalt areas east of Marrakech. These formations are typical of basaltic lavas found in many parts of the world. As the lava cooled, gas bubbles were trapped, leaving cavities. Later, mineral-rich solutions moving through the formation deposited minerals in the cavities. In Morocco, this was predominantly quartz. In some respects, these localities are similar to the basalt formations of southern Brazil, Uruguay and northern Argentina, but are not nearly so large, well developed, or well known. At some sites, the quartz is crystalline and either clear or amethyst, forming geodes. Some geodes also contain goethite, either included in quartz crystals or as free-growing needles. At other sites, the quartz was deposited as agate. This can occur in a variety of colors, including carnelian, blues and reds. The agates may be in solid nodules, or may form little stalactites in geodes, sometimes with druzy quartz. One thing I have not seen from this area is zeolites, which can be found in some similar formations in other parts of the world, such as India or Brazil. Geodes and agate nodules are usually collected in Morocco where they have been exposed by weathering.

As we proceeded east from Marrakech, we approached the High Atlas Mountains, and soon started to see a great number of rock sellers alongside the road. Some of these guys had nothing more than a sack of rocks, and would hold up a couple to entice passing vehicles. Others had small tables or little stands, and a couple had respectable shops. Most of this material was junk! The usual offerings were chunks of white quartz geodes, often dyed outlandish colors like hot pink, metallic gold, orange and a shade of violet that did not even come close to amethyst. One shop that we stopped at, though, had nice material, including good agates, chalcedony stalactites and amethyst geodes.

After crossing Tizi n'Tichka Pass, the highest vehicular pass in Morocco at 7,415 feet, we approached an agate collecting site that Adam knew of near the town of Agoum. Adam told us that this was a "bucket locality," meaning the only equipment you needed was a bucket to put your rocks in. I didn't have a bucket, so I just shouldered my knapsack when we arrived at a small parking area. We then struck out up the side of a hill on a trail that was better suited for the goats we saw along the way than for humans. After about a 20 minute hike under blazing sunshine but pleasant temperatures, we arrived at the crest of a small hill. The ground was literally paved with agates. An area of perhaps 2 or 3 acres was covered with nodules and geode fragments. They ranged in size from under 1 inch to almost 1 foot. Most of the agates were whitish or cream colored, but some were carnelian. I noticed that the smaller ones seemed to have the best color.

There were also sections of geodes with clear quartz crystals up to about ½ inch, some with included goethite. One fellow found a doubly terminated "floater" quartz crystal about ⅞ inch long that looked like a Herkimer diamond. There were no whole geodes to be found, the Moroccans had collected these. They didn't seem to bother with the agates, though. Even being selective, I had all I could carry in about 15 minutes. I was glad the hike back was downhill!

We spent the next few days in pursuit of trilobites and other fossils in the vicinity of Erfoud, in eastern Morocco. We had intended to visit a lead mine near Taouz, near the Algerian frontier, but lack of time and a persistent sandstorm forced us to nix this visit. I have since learned from an acquaintance who visited this site on a more recent trip that there is not much to see, just some holes in the ground. However, I was able to obtain some nice material from Taouz from a dealer near Erfoud, including vanadinite on a matrix of black goetnite (a very nice color combination), and what I think are green smithsonite crystals (the dealer did not know). This dealer also had some fantastic fossil dinosaur teeth that had been found in the same area.

After leaving the trilobite localities of eastern Morocco, we again crossed the High Atlas Mountains to arrive at one of the most important mineral centers of the country, Midelt. On the way, we experienced a striking change in weather. In Erfoud, it was hot and dry, and a sandstorm was occurring. Somewhere between Erfoud and Midelt, though, a cold front passed, causing thundershowers, and by the time we reached Midelt, it was cold and windy. Though it was early May, the lower slopes of the mountains had a bit of newly fallen snow, which disappeared by the next day. This was all kind of a shock to my system!

Midelt and nearby Mibladene and Aouli are among the best known locations of metallic ore vein deposits in Morocco. The major metallic deposits are classified as Mississippi Valley type deposits, named for the lead-zinc deposits of the central United States, including those of Missouri, Illinois, Kentucky and Tennessee. Typically, these deposits consist of veins of metallic sulfides and associated minerals, contained within strata of sedimentary formations. Oxidation of the sulfides produces a variety of secondary minerals, including some of those most sought after by collectors.

In the Mibladene area, the primary ore minerals are galena and chalcopyrite. The most abundant gangue mineral is barite. Secondary lead minerals include cerussite and vanadinite, secondary copper minerals, malachite and azurite. From a collector's viewpoint, vanadinite is perhaps the most important mineral of Mibladene; some of the finest specimens in the world have come from this locality. Mibladene vanadinites are typically a brilliant reddish orange, with crystals up to a centimeter or more, and often grow on top of bladed barite crystals.

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The ground at this collecting site near Agoum is literally paved with agates and geode fragments.

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The availability of minerals from Mibladene is due largely to the lead mining industry that developed to exploit the galena deposits. Extensive underground mining has taken place near Mibladene and Aouli. However, at present, none of these deposits are being worked commercially, mining ceased in the 1970s. Entry into the old mines is officially forbidden, but new material is still coming out. Nice specimens of vanadinite, barite and cerussite can still be had from dealers in Midelt.

The town of Mibladene still exists, though it is probably smaller than when the lead industry was in full swing. Aouli, though, is a genuine ghost town. Built in the gorge of the Moulouya River, Aouli once had mines with all of the support structures, including a smelter, stores, a movie theater, a mosque and houses for thousands of people. Now, only a caretaker lives there.

I have been fortunate enough to have been able to travel to many interesting places, including Brazil, Chile, Costa Rica and Thailand, but it was near Mibladene that I had one of the most memorable experiences of all my travels. Adam had arranged for us to visit a small mine with two Berber brothers whom he knew. Our base for that day's expedition turned out to be the home of the brothers's family, who were nomadic shepherds that lived in a traditional goat-hair tent. Being the friendly, hospitable people that they are, they invited us to have tea with them in their tent before visiting the mine, and lunch afterward. I felt like I was in the middle of a *National Geographic* article! Like most of you, I live where life is changing faster than I like to think about, but here were people who still live pretty much the way their ancestors lived for thousands of years. To personally glimpse their way of life was fantastic.

Getting to the mine took a short ride, followed by a short hike, up into the hills near the tent. The area is quite scenic, not unlike parts of the western United States, with rocky hills, covered with a sparse layer of scrubby vegetation. This was not a major mine, but was probably a site of exploratory work during the heyday of lead mining [illegible] in the 1950s or '60s. It consisted only of a few surface pits and one short adit, running perhaps 100 yards back into the side of the hill. The brothers were working it for specimens, primarily malachite, and referred to it as the Boucan Mine. They lit up a couple of old-fashioned carbide lamps and led us back into the tunnel. Now, going into old mines is not something that I would normally recommend. However, the tunnel seemed solid, with few fallen rocks, and the brothers work it regularly, so with a bit of trepidation, a small flashlight, and my hammer and chisel, I went on in.

The tunnel roughly followed an ore vein. Like in many of the deposits in the Mibladene area, the primary sulfide mineral was galena, with a little chalcopyrite. Blebs of these minerals could be seen in a matrix of massive barite. The most abundant secondary mineral at this site was malachite, with some azurite. Both of these minerals occurred as crusts and as tiny crystals in small vugs in the barite. Some of the vugs also contained a few small barite crystals. Though galena was common, I did not see any secondary lead minerals, such as cerussite. The brothers helped us to collect specimens of the malachite and other minerals. None of it was really great stuff, but it was interesting, nonetheless. And being able to see such a deposit up close for myself was great.

Later, back at the tent, we were able to buy some nice material that the brothers had brought from other sources, including vanadinite and cerussite, for very reasonable prices. We were also able to obtain some great material from dealers in Midelt, including some very fine azurite crystals from Toussit, some an inch or longer and absolutely flawless, as well as honey-colored anglesite crystals from the same locality.

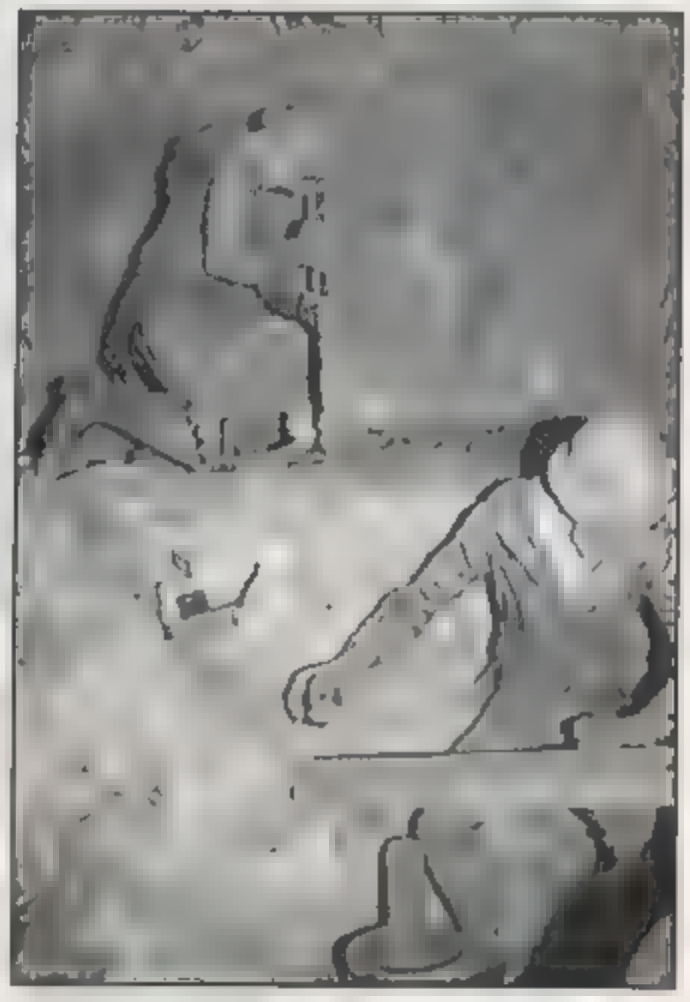
Soon, it was time to leave Midelt. After almost two weeks of collecting and buying rocks, minerals, fossils, a small carpet, and various other souvenirs, Lisa and I had all we could carry. On our way to Fes and Rabat, though, we passed through one more area that deserves mention, not necessarily for rocks, but for its natural contrasts: the Middle Atlas Mountains. If you went to sleep in the car leaving Midelt and woke up a couple of hours later, you might think that you were on another continent. Most areas of Morocco are semiarid to extremely arid, with trees only along rivers or at oases. The Middle Atlas Mountains, in contrast, have moist, verdant forests of cedar, at least where they haven't been logged. These mountains seem to catch the moisture-bearing winds from the Atlantic. In the winter, the area gets several feet of snow, and a number of Swiss-style ski resorts are located there. If you didn't know better, you might think you were in the Alps rather than on the tip of Africa. That is, until you see the wildlife. The forest is home to the macaque, or Barbary ape, a tailless monkey about as big as a medium-size dog. In some places, they are used to being fed, and will come to cars and beg for handouts. We encountered a troop of 20 or 30, males, females and young of all sizes. Seeing them up close was one of Lisa's favorite parts of the trip.

Finally, we returned to Casablanca to catch our flight home. After two weeks of fascinating stops and shooting more than 20 rolls of film, I was beginning to suffer from sensory overload, not to mention muscle aches from lugging all those rocks. It would be good to get home, but I will certainly never forget my experiences rockhounding in Berber country.

Germany's Museum of Ancient Mining

Showcasing the Forgotten Technology

A model of ancient Roman mining shows how lifting power was supplied by workers with simple machines (Photos by the author)



This model gives an indication of how difficult mining by oil lamp would be.

by Murray Eiland

My first visit to the German Mining Museum in Bochum Germany, was a tremendous shock. I was only dimly aware of what to expect, and I imagined that there would be several rooms, perhaps dimly lit, containing modern mining equipment that would be of little real interest to anyone not intimate with mining. Although I had toured modern working mines, the machinery had not sparked any real interest in me. Roman period mining was my interest, and though it was full of the darker side of human history, it had always seemed more approachable than modern mining.

Ancient mining is largely the forgotten technology. While many museums focus upon metal, in the form of ancient jewelry or displays of tools such as axes, there is little interest in how the metal was won. Many ancient civilizations were metal poor, and needed to obtain gold and silver for coins, tin for making bronze, and even copper. Perhaps more than warfare, the history of civilization has focused upon metals, specifically how to get more metal with less work. There are so few museums that cover this topic that it was worth a chance to visit one. So it was with hope that I took a train from Frankfurt to Bochum.

A reconstructed fossil trackway is flanked by cases of fossils.

The Ruhr region of Germany has a long history of mining. It is certain that the Celts were active in the area, and the Romans had several large settlements here. By the time Charlemagne made nearby Aachen the capital of his empire at the beginning of the Middle Ages, the Ruhr had been mined for more than 1,000 years. Bordered by Netherlands to the north and France to the west, this heavily populated region has been devastated by two World Wars. From the main station, I took the underground to the Bergbau Museum stop, and approached the unknown.

When I first saw the outside of the huge museum I was deartened. After spending about 20 minutes there, I realized that I would spend the day and would return many times. It was not so much that the museum contained Roman material directly of interest to me. I saw so many things relating to historical mining that I fully understood how little I knew about it. That's a bad feeling in any place other than a museum. I was suddenly eager to understand tools and machines that, had I had seen them before, I would not have bothered to look at, much less examine. Not surprisingly, I was not alone in my assessment. About 400,000 people visit this museum per year, though this number may not include repeat visits.

While the labels and descriptions of the exhibits are in German, the museum publishes a very good guide in English, and most of the displays are fairly easy to follow. I am not a linguist, but I encountered no problems. Can mining be appreciated as a "universal language," like visual art? Perhaps. This is one of the most frequented museums in Germany, though it is not devoted to art, and not in the capital city. Nor is it a small, regional museum. The exhibits cover about 10,000 square meters. They also cover much more than mining, though this, of course, is the unifying theme.

The museum was founded in 1930 with the primary purpose of documenting the coal mining history of the area. Many of the exhibits are built around teaching materials and models used for training miners. Further material was obtained from the Museum of Mining and Metallurgy in Berlin, which was founded in 1868 and dissolved in 1917. The mineralogical collection was augmented in 1975, when the local Geological Museum, founded in 1864, dissolved. This museum had, in turn, been composed from the collections of the Mines Inspectorates in Essen, Werden and in Bochum, which were particularly strong in the northwest German Carboniferous formations.

There is a special emphasis on economically important raw materials. A centerpiece is a petrified tree from the Carboniferous that is 2.5 meters high, and has roots preserved intact. There are more fossils (many of them plants from coal) as well as minerals, selected for their appearance, that give a break to pure mining history. The museum presents a broad range of information to educate about earth science in general, as well as to preserve mining history. There are examples of crafts made by miners and about miners, historical photographs, books and hand written documents. Although many mining records were lost during war, local mining companies, faced either with closure or with restrictions on space, have donated much material to the museum. These archives may be visited by appointment. There are also a number of specialists affiliated with the museum who engage in research. Using modern analytical equipment, materials such as bronze tools can be characterized in the hope of learning the origin of the raw materials, and what technology was used to turn it into metal.

There is also historical research. Using modern sociological sensitivities, the human aspects of mining – from the migration of workers, to women miners in wartime – can be illuminated. There are also archaeological projects under the direction of the museum, with a particular emphasis on the Near East, where very early evidence of mining is preserved in abundance. In the absence of rain and plant cover, evidence is both easy to see and more likely to survive. The wide range is also reflected in the scope of the museum, which pays attention to the prehistoric use of flint and salt – two things that may not spring to mind in connection with mining – as well as iron and coal.

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German/ *from page 57*

An important part of the museum is the demonstration pit, which has been built in the marl zone 15 to 20 meters beneath the museum. Two and a-half kilometers long, it gives an "authentic" feel of being in a mine. There are many machines on display that show just how much technology has changed the process of mining. This is particularly welcome after looking over materials from the distant past. While the human element will always be important in mining, what would have taken years in antiquity can now be done in hours by huge machines with ominous-looking cutting surfaces.

Not to be missed is the tower directly above the mining pit, which was moved to the museum in 1973. The highest part of the platform is approximately 60 meters high and gives a good view of the region. It is an interesting note that while Bochum was one of the most important coal-producing towns in Europe, there are no active coal mines in Bochum today. This seems to be a trend in Germany, nationally, there is an abundance of poor iron ores. The Salzgitter mines yield about 33 percent iron, while ores from Brazilian mines yield between 60 and 70 percent iron. Is the future of the German mining industry to be found in museums?

I found the displays that discussed technological change over time the most interesting. What is the difference between a shaft that is made by pecking with a stone hammer, as during the Neolithic, and one that is made using a metal pick, as used by the Romans? Different tools leave very different marks, so it is possible to date shafts by their distinctive markings. While a picture of such a thing is not informative, seeing representative examples together to compare for oneself is something of a triumph. After coming to grips with the early evidence, the evolution of various power hammers becomes more interesting.

Next are many cases of mining lamps. As an open flame in a mine can be very dangerous, considerable effort was put into perfecting a safe flame. There are also mining uniforms, mostly from the 19th and 20th centuries, bearing strong resemblances to military uniforms. Under state control, the extraction of metal was regarded, if not as a noble pursuit, then as a vertical one. The museum also exhibits the results of mining. Jeweled silver cups and vases are a reminder that metal is a basic measure of wealth.

Another real strength is the museum's collection of models. I usually have little time for models, which can be stiff and boring. In this case, however, they were unusually informative. While some of them reflect the dated conceptions of the past, they capture three dimensionally the functioning of, at times, very complex ma-

The museum includes displays of crafts made by miners and about miners.

chinery. Before the industrial revolution, there were problems in raising loads of ore up from a deep mine, as well as taking workers to the depths and back. Water was also a constant problem. Raising water from the depths without a steam engine required a huge effort. Wheels powered by animals—and by people during the Roman period—were the highest technology available. Shafts also had to be sunk at regular intervals to provide air, a consideration that limited the extent of many ancient mines.

Models also convey one of the most important aspects of historical mining, namely, what it does to the landscape. The European landscape still bears traces of mining by the Greeks and Romans (particularly in Mediterranean countries), as well as Medieval and early modern miners. With a grasp of the capabilities of early miners and an understanding of how they dealt with ore, hills on the landscape resolve into traces of mining.

In short, it would be difficult to be bored in such a place as the German Mining Museum. There are fossils and mine art, exhibits on social aspects of mining, and exhibits designed for children. There is such a wide range of things to see, the main question you will ask yourself is, "When can I come back?"

The German Mining Museum is open Tuesday through Friday, from 8:30 a.m. to 5:30 p.m., and Saturday, Sunday and public holidays from 10 a.m. to 4 p.m. It is closed on Monday, December 31, January 1, and May 1 and 24-26. You can take a taxi to the museum, or take underground line U35 to the Bergbau Museum stop. The museum is a short walk away.

A fossilized Carboniferous tree trunk with roots sits at the center of a display of regional fossils and minerals

Mexico's Famous

by Bob Jones

Sometwhere in the remote desert east of Naica, Mexico, is a newly discovered selenite deposit. It was found by an old-time mineral prospector who wandered into a narrow gulch and found a small outcrop of selenite crystals. He told a friend, who had the good sense to contact Benny Fenn, a highly respected dealer in Mexican minerals from Las Cruces, New Mexico. Fenn's reputation is impeccable as both a dealer and a digger. His most fantastic find was the brilliant yellow botryoidal manganite of San Pedro Corralitos, Mexico, nearly 30 years ago. He is continually bringing fine Mexican minerals, including wonderful selenite, to the United States.

Selenite is one of Mexico's leading mineral specimen products. It occurs in a number of mines and deposits, sometimes in spectacular crystal groupings. The best known selenite cave, but perhaps not the best ever found, is at Naica. Known as the Cave of Swords, this wonder of nature has been preserved and exhumed time and time again. The crystals are thickly clustered and of superb form. They often grow to arm and leg lengths. Naica also yields fine, smaller selenite clusters. On a recent visit, I saw a few groups for sale, though the supply today has diminished because of actions taken by the mining company to restrict underground collecting by miners. This is understandable, since time taken from mining to collect specimens is time taken from the company's production schedule.

Other deposits also produce spectacular selenites, which are suddenly finding new favor as spectacular displays for home decor. The most prolific sources of selenites in the past few decades have been Naica and the mines of Santa Eulalia, sometimes called Aquiles Serdan.

There are several mines in Santa Eulalia that seem to all be interconnected. First is the original mine, El Potosi. Nearby are the Buena Tierra and Melissa mines, while on the other side of the mountain is the San Antonio Mine, which is still producing. All these mines have produced marvelous crystal specimens. At various times, rhodochrosite, hemimorphite, pyrrhotite, pyrite, ludlamite, calcite and much more have come from these depths, and fine selenites have been consistently mined.

I had the good fortune to visit three times what was perhaps the finest selenite cave ever found in Mexico. It was discovered in 1979 during mining operations at the Buena Tierra mine. Former Arizona Sonora Desert Museum curator Bill Panczner and I, accompanied by our sons Evan Jones and Chris Panczner, were fortunate enough to get into the cave shortly after it was opened and long before it was publicly known, and finally destroyed. Known as Caverna de Santo Domingo, this was a 120-meter long cavern with selenite

Selenite Cavern

A modern miner removes rock from a mine one bag at a time.

Selenite ram's horns like this one from the Evan Jones Collection are commonly encountered in Mexico's silver mines.

crystals that spanned 18 feet and contained crystals up to 7 feet long. It was an amazing experience.

Currently, small white clusters of selenite are often available at shows. The crystals are usually clear, or nearly so, and sword like in form, and they often show fishtail twinning. The crystals diverge in attractive sprays, making home decor an increasingly popular use for them. Other selenites eschew the prismatic form, developing instead as perfect monoclinic crystals an inch or more in length. These can be perfect textbook examples of the monoclinic crystal form, and serve as study examples at shows.

What attracted me to the new selenites coming from Mexico today was a display at Fenn's booth in Tucson and again at the Pomona Show. He had obtained blades a foot and longer from the new deposit and, after cleaning them, mounted each on a small light box with a rotating series of color lights shining up through the long axis of each blade. Slowly, the crystals would change from clear and colorless to blue to red to orange to yellow to violet. It was an exceedingly effective display. Needless to say, I now own such a display crystal. I was lucky enough to collect and prowl at the new deposit. I used a hacksaw to cut it away from a much larger mass of intergrown crystals. This is the method used by miners to collect the better crystals.

This new deposit, located a torturous 50 miles northeast of Naica in the middle of nowhere, was first prospected by the miners who now own it. If the mine has a name, I don't know it. Fenn worked with the miners to develop the deposit. As the miners worked their way into the side of the gulch on the exposed selenite, they were able to extract some fine, clear crystals. But as they penetrated farther, they ran into a solid wall of orange-red mud, which completely filled the water channel bearing the selenites. The surrounding rock proved to be nearly pure massive gypsum. The mud completely coated the exposed crystals. This mud proved to be tenacious stuff, not only coating but actually combining with the surface selenite of the crystals. Soaking has proven to be the most effective way of removing the mud to expose the clear crystals.

Once the red mud formed on the crystals, a secondary growth of selenite occurred right on the primary crystals. This trapped the colorful mud between the first and second phases of growth, making a not unpleasant addition to the otherwise colorless selenites. The second phase did not completely encase the primary crystals. This made it possible to clean the red mud off the exposed faces of the primary crystals. The result is a wonderful combination of clear crystals with a jacket of orange-red mud locked under the outer growth of the second phase crystals.

continued on next page

Selenite Caves/ *from page 65*

The area where the crystals occur is nearly solid gypsum, the source of the calcium sulfate absorbed by groundwater as it flowed through the gulch. Initially, the crystals grew in a small opening, perhaps a small fault or channel in the gypsum rock. This enabled water-clear crystals of selenite to develop. What happened next was probably some sporadic flooding, which heavily eroded the local soil, then carried it into the gulch and down into the selenite crystal channel. The flooding turned reasonably clear water into a muddy torrent that scoured its way into the cavity and coated the existing crystals with the orange-red mud. After a period of flooding, the groundwater cleared and resumed its normal pattern, absorbing calcium sulfate and depositing it on the mud-coated crystals. The effect is quite stunning!

The method of removing rock from mines has not changed in thousands of years

The crystals mined from this deposit so far usually have one or more "water bubbles," more accurately described as air bubbles in trapped solution. These bubbles are common in selenite, and are indicative of growth in a watery solution.

Just how fast selenite can grow remains speculative. In some cases, the crystals seem to have grown by inches in a few months. In other cases, it apparently takes hundreds or thousands of years for large crystals to form. The mineral content of the growth medium and the temperatures involved all play a role in the rate of selenite growth. In fact, when bruising has occurred on selenites, you can submerge the crystal in running water, and over time the bruised portion will dissolve away. This is partly because bruising exposes more mineral surface to the running water, and selenite is slightly soluble. This is the technique Ivan uses to clear away minor scratches and bruises on his crystals.

The crystals that have been recovered thus far are large, some achieving a length of 5 feet. Most are around 1 foot in length. Since the crystals grew in all directions, they interfered with each other as they grew, ending up in a tangle of thick, terminated, and sometimes very large selenite clusters.

The mining of these clusters is being carried on by relatively primitive and one might say historically interesting methods. The deposit is very remote, with barely a track leading to the gulch where it formed. Four wheel drive is a must. Itinerate miners typically work such a small deposit by hand, at first using hammers, chisels and shovels. As this deposit developed into a small cavern, the miners built a small retaining wall to keep the sporadic flows of rainwater from spilling into the hole. They also asked Ivan to get them two pieces of modern equipment, a portable generator and a power chisel to break away the hard mud and soft host gypsum so that more and more crystals could be mined.

Yet, despite the modern tools and equipment, as we approached the mine we saw an elderly miner emerge from the depths with a leather bag slung on his back. The bag was loaded with over 150 pounds of rubble, or *tepetate*. Using a head band and a thick cloth as a back cushion, the miner was hauling waste rock from the selenite depths to a nearby dump. This method of transporting rubble from the mine depths dates to before Roman days.

In the early days of mining in Mexico, such a worker was called a *tamatero*. Early mining books contain woodcuts and drawings of *tamateros* using exactly the same technique to carry heavy loads to the surface from the depths. I found it remarkable that this ancient method is still used in small mining operations in Mexico, but I should not have been surprised. On an earlier visit to Santa Eulalia to visit the Caverna de Santo Domingo, I saw two burros with classic wooden frames on their backs designed to hold 5 gallon cans of ore. They were the property of two independent miners who work ore veins that are either abandoned or ignored by mining companies because they are too small, too low grade, or too thin to work. It is truly amazing that while in American mines huge trucks, massive electric shovels, and British hoisting equipment move tons of ore, just south of us miners are still using animal and human power to accomplish profitable ends! It was particularly exciting for me, a student of mining history, to actually see a *tamatero* hauling *tepetate* from the depths.

I must confess that I could not get back to the mine on my own. We left Highway 45 near Saucillo, south of Chihuahua. We headed east following bad gravel roads, sometimes simply ruts. Hours later, we ended up on a badly dissected flat region and in one of the countless gullies we came upon the mine. All I know is that the mine is about 50 miles northeast of Nates, which is famous for its own selenite cave. It is really exciting to visit a new deposit, and it is also exciting to know that Mexico, a major source of wonderful minerals over the centuries, still holds pleasant surprises!

Rock Science

by Steve Voynick

GETTING THE LEAD OUT

To most folks, "get the lead out" is a familiar expression that means "move it." But a mineral collector might take it as a suggestion to display some of his or her specimens of lead-containing minerals. Among them are such colorful and eminently collectible minerals as reddish wulfenite (lead molybdenum tungstate), brilliant red or orange crocoite (lead chromate), red vanadinite (lead chlorovanadate), and green pyromorphite (lead chlorophosphate-arsenate).

Other lead minerals include the white carbonate cerussite, the white sulfate anglesite, and the most familiar and common lead mineral, galena, or lead sulfide. Lead is also an essential component of such sulfosalt minerals as jamesonite, zinkenite and boulangerite. Finally, there are bournonite and seligmannite, the two end members of the bournonite group of lead copper sulfides in series with arsenic and antimony.

To those in health and environmental fields, however, "get the lead out" has another, much more serious meaning. In this context, the expression refers to reducing the amount of unwanted "environmental" lead in our air, soil and water. Environmental lead can enter our bloodstreams and accumulate in our bodies. In sufficiently high levels, it can adversely affect mental and physical development in children, and can cause anemia and kidney dysfunction in adults. Environmental lead was such a serious medical problem a generation ago that most Americans had elevated blood lead levels.

Where did all that environmental lead come from? Lead has an enormous number of uses – everything from fishing sinkers and pigments to radiation shielding in hospital X-ray apparatus and the anode plates in lead acid automotive storage batteries. But the leading contributors were paints and gasoline. For nearly a century, lead compounds served as the standard pigments and anticorrosion additives for paints. But when aging lead based paints peeled and crumbled, the lead was sometimes ingested, most often by children. Similarly, lead-based additives in gasoline reduced engine knock and increased valve life for decades. But exhaust emissions from leaded gasoline spewed large amounts of particulate lead into the atmosphere.

By the 1970s, lead had been banned from use in house and most industrial paints, and replaced by white titanium dioxide and colorful, synthetic organic pigments. Regulations also banned lead in gasoline and in solders used in food cans, and mandated large reductions in the lead content of industrial air emissions. During the last 25 years, the United States did indeed "get the lead out," as shown by a 78-percent decline in average blood lead levels.

Lead, along with gold and copper, was one of first metals ever used by man. Early Egyptians used lead-based pottery glazes, and Romans later used lead water pipes. In fact, our word "plumbing" derives from *plumbum*, the Latin term for lead.

Although lead is fairly reactive and forms many mineral compounds, it also occurs, however rarely, as a native metal. Accordingly, miners in some placer districts of central Alaska have another meaning for "get the lead out," since bits of native lead sometimes clog their sluice box riffles.

Despite the negative image of lead resulting from its former uses in gasoline and paints, the metal has many uses that do not create health hazards. The batteries in the nation's fleet of 160 million highway vehicles, along with 500,000 electric airport, mine and industrial vehicles, contain 4 billion pounds (2 million tons) of lead. Each year, another 1 million tons of lead are used to manufacture storage batteries for new vehicles and replacements for old batteries.

Overall, American industry uses 1.2 million tons of lead each year. Nearly three-quarters of that lead has been recycled, mostly from old automotive storage batteries. Another 300,000 tons is mined as "new metal." The primary lead ore is galena, and 90 percent of American mine production comes from seven Missouri mines.

Lead has served man for some 6,000 years, and scientists today continue to find better and safer ways to use the metal. So whether we are health and environmental workers, mineral collectors, or just folks in a hurry, we'll all, in our own ways, continue to "get the lead out." ❖

The Cutting Edge of a PRIMITIVE ART

Flintknapping Is Alive in Florida

Bob Berg and friends have plenty of rock chips on the tarp as they knap down points for their spears. (Photos by the author)

Knapper Mark Bracken displays some of his best pieces, fashioned from Florida flint.

Woody Blackwell shows his technique as he works some near-translucent "root beer stone" into a point.

Primitive Art/ *from page 73*

From Stone to Art

As I stroll past piles of multicolored flint, display cases filled with arrowheads and stone knives catch my eye. I duck under a canopy to take a closer look. Here, two older fellows are sitting up against a longleaf pine, busily knapping away. We get into conversation. Knapper James L. Stokes is from Groveland, and he's working an arrowhead, or point, with an unusual little stick. It's got a screwdriver shape, and he uses it to notch the arrowhead.

"I used to use the Ishi sticks," Stokes says, pointing to a stick with a copper tip, "but my arthritis couldn't take it anymore. I came up with this pressure flaker, and it works great."

While most knappers use modern lapidary saws and grinders at home to trim and smooth the rough rock, when they go to work the stone, they step back into the Stone Age. At another booth, I watch as several knappers use the Ishi sticks, some have copper ends, some steel. They don't try to cut the rock, but rather "press" it, causing the conchoidal fractures that are so crucial to knapping. One man works a piece on the grindstone to, as he says, "smooth the edges, spread the energy before flaking." Once a stone is chipped down, or reduced, to where the color is showing, great care will be taken to plan and execute each subsequent strike.

Under a picnic pavilion, a large crowd of admirers gathers around Claude Van Order, the undisputed king of Florida flintknapping. He's talking about heat-treating rock, and fingers some colorful, heat treated pieces.

"As a kid, I 'blew up' a lot of rock trying to figure out the process. I'd heat water and pour it over some of the prettiest points I'd ever seen. Wham! Gravel." He goes on to explain how heat-treating is a crucial part of the art, and how ancient pieces treated as high as 1,000 degrees F have been found intact. Heat treating "tightens the pores and the micro cracks," Van Order says, and "brings out the color inherent in the stone." Heat treating puts a piece of dull, white flint through an oxidation process that pushes it through red, blue and yellow hues.

Knapper Woody Blackwell also has a gooday following as he sits outside a tent with displays of some of his most beautiful points. He works a piece of rare "root beer rock," a caramel-colored translucent jasper, as other knappers look on, envious.

"No, you can't have any," Blackwell jokes as one fellow pokes through his pile of rough.

Dealer Mark Bracken found him that rough. An active knapper himself, Bracken takes just as much joy in hunting for "good rock." He relates stories about finding the perfect road cut and hauling that out of Georgia river bottoms.

"I love my rocks," Bracken says. "It's hard to watch a piece get sold off the pile. I gotta just say to myself, 'Well, that's gravel!' But I can't keep it all." As a result, he often saves the prime pieces for the top knappers.

"I once bought some opal, and the dealer said 'What are you going to do with that?' When I told him, he said, 'Hey, you can't chip that!'"

All the more challenge for a knapper. Bracken claims an 80 percent success rate on his rock these days. "You need to be in control or the rock takes control." His favorite rock to work is the famed Tampa Bay agatized coral.

"You've got to have a passion for this stuff. It's been with me since childhood."

Bracken seems energized by the swirls of knappers who look over his pieces of rocks and tools. "You've got to have a passion for this stuff," he says. "It's been with me since childhood. And you've got to have a fat wallet, or the free time to hunt for your own rock."

Bracken isn't the only one out there searching for new Florida and Georgia stone, but you won't get these fellows talking about their carefully guarded sources. "You can work all day," says Bracken, "and only find two good stones." Yet he loves the detective work of finding just the right flint. He gives a conspiratorial wink. "Here's one hint. Don't look for agatized coral in Tampa Bay. There's plenty of it on dry land."

Learning knapping works like an apprenticeship. Many of the fellows here the art seems to draw in more men than women—studied with Van Order or someone he taught 10 or more years ago. It takes a couple of years under proper instruction, and having some understanding of the original artifacts helps. Bracken also teaches classes.

"You hit these plateaus in the learning curve," he says. "You can teach by example, you can teach how-to, you can do it very slowly, but at some point the student has to say 'why?'"

Why does the stone act like it does? Why is the shape so important? Bracken mentions his first experience with a museum piece.

"I looked at it, and asked myself, how did they pick up this rock and make this? It looked machine made, perfect. I thought 'how do I do this?' That was the beginning of the quest." His advice to wannabe flintknappers? "Find a mentor. Once you find one person in the chain, you're in!"

Bracken's quest has led him to artistic satisfaction. "It exhausts me mentally to make three points. It saps my concentration to sit on a 5 gallon bucket and stare at the rock for two hours. But when it's done, it's a very satisfying moment."

It's a Florida Thing

As a Floridian, I've picked up bits and chunks of flint out of my own yard, striped with odd spots of red and yellow. But the native stone gathered here dazzles, and that's why the knappers descend on this event. You'd be surprised at the many colors of Florida stone. Flint shines with a gloss of salmon, gray, peach and butter yellow. Opalized phosphate gimmers like cut glass, with strips of saffron, mauve and evergreen, and swirls of bubble gum and mustard. Some knappers take on heartier challenges by working softer fossils (often mastodon or mammoth tusks), stromatalites, and petrified wood.

Florida's knappers often model their work after items found here in the state. And for participants in the annual flintknapping contest, the use of native stone means higher scores as they chip out three patterns based on Florida's past. The Florida Bureau of Archeological Research sets up a display showing off Florida's many arrowhead styles, some of the oldest of which were found in the Santa Fe River just north of Gainesville.

This was the third year of the Knap-In at Paynes Prairie. With little more than word-of-mouth advertising amongst the knappers and the primitive arts community, participation rose from 23 knappers the first year to 90 demonstrating their skills here today. "This is the finest knap-in in the country," said one attendee.

The Wild Side

With all these points being created, you might figure that someone would want to put them to use. Stopping at another tent, I meet three fellows intent on working the rock. One of them looks like Davy Crockett, clothed head to toe in deerskin and furs. "Call me 'Legs,'" he says.

It turns out that Legs, a.k.a. Wendell White, is an expert on primitive weapons, particularly the atlatl. He leads me off to a spot along the road where they've set up

a target, and lets me to choose a spear. You've got to see an atlatl to fully understand it. Ancient hunters used it to more accurately throw their spears. Legs and his buddies Bob Berg and Micah Mones have been out hunting wild boar with their creations, helping (with the state's permission) to thin down some of the population along the Silver River near Ocala.

"Three guys can spend a whole week to get just one little free-range Florida boar!" Legs says laughing. "But it's lots of fun."

After watching Legs hit the bull's eye, I try my hand — with the expected result of driving the spear into the dirt a few feet shy of the target. Still, I'm surprised (how far it traveled). He offers more encouragement and I try again. Alas, it does not get me added. "I'd never make a hunter," I say. Back at the tent, Berg fills me in on their little boar hunting adventures.

"You wouldn't believe what I've gone through in some states," he says. "Many fish and wildlife commissions don't even know what an atlatl is! And sometimes it's a sin of omission. Hunting with an atlatl isn't legal just because it never occurred to them that someone might want to use primitive tools."

As it turns out, the atlatl is the perfect tool for thinning Pennsylvania's suburban deer population, it's safer than archery.

"It's like therapy," said Berg. "It's like sitting with a fishing pole, you know you'd like a bite, but you're out here for the experience, as well."

The knapping bug bit Berg when he was 10 years old. "I found an arrowhead, and went to sleep that night with it clutched in my hand. It was neat to learn about where it came from and how it was made. When I took my first 'regular' job, I was bored to death. So I went to the library, found an article from 1938 on the atlatl, went out to my garage and made a few."

He followed up by enrolling at Alfred University's School of American Craftsmen, where he took independent studies in woodworking. After five years of self study, he went to the Flint Ridge Knap-in and moved on to working the rock. Once he had knapping down, it didn't take long for the atlatl to take over Berg's life. He now runs Thunderbird Atlatl, a mail order business based in Candor, New York, and travels all over the country to show his wares at primitive arts festivals like this one.

He continues to chip at his flint. "What keeps me in the business isn't this stuff." He holds up the arrowhead, inspects it, and grins at Legs and Mones. "It's the people."

Minnesota Staurolite

Twinned staurolite crystals are commonly known as "fairy crosses" (Photos by the author)

Collecting White Water Fairy Crosses

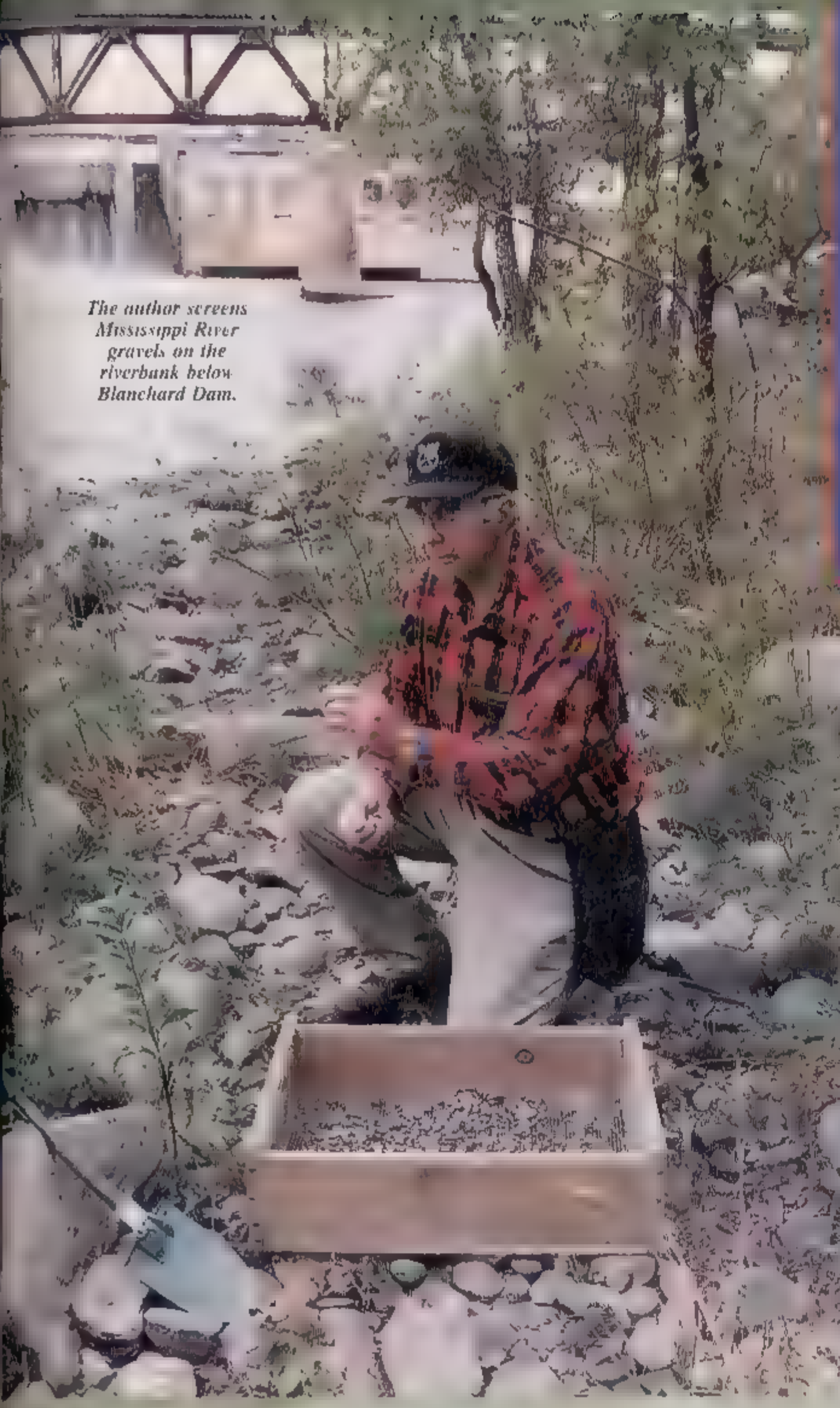
by Kenneth H. Rohn

Traveling through the fertile bottomland of the Mississippi River on Minnesota's Great River Road (U.S. Highway 10) between St. Cloud and Little Falls, you wouldn't suspect that within a few miles of the town of Royalton lies an abundant collecting site. One of the reasons is vast immense corn, potato and sunflower fields line both sides of the highway for miles on end. There seems to be no place to hunt for gemstones.

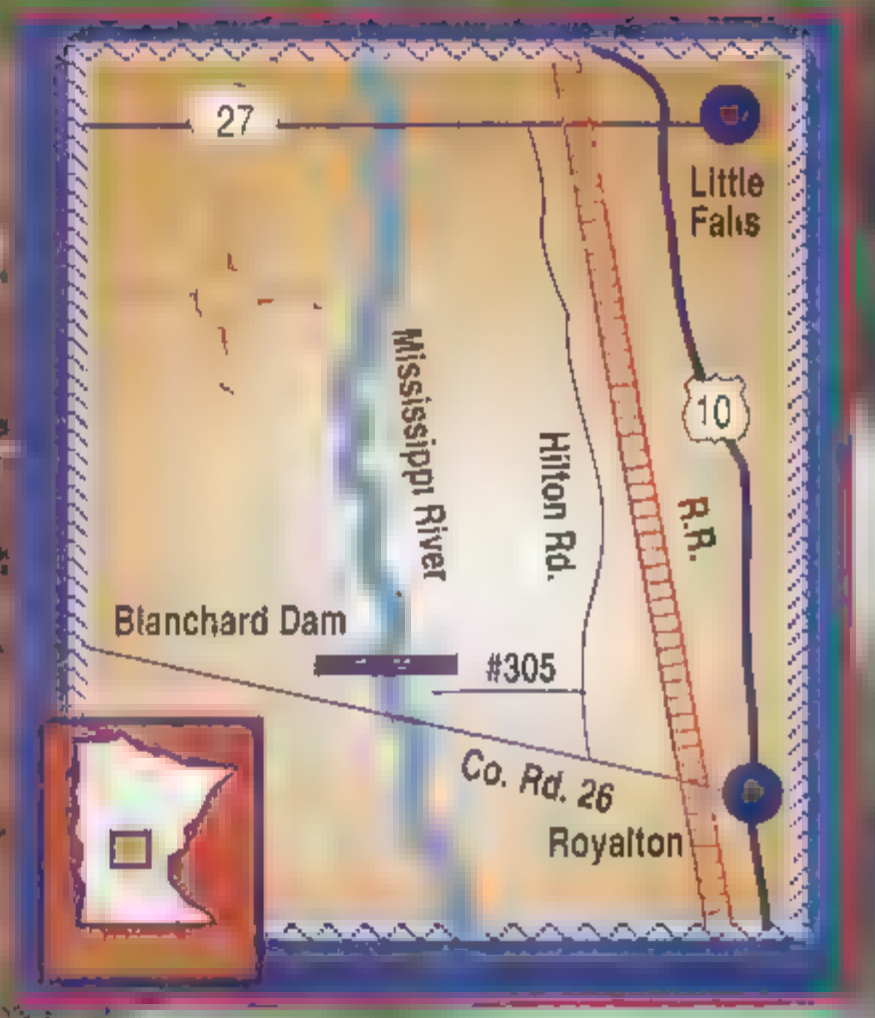
The primary collecting site for staurolite crystals, beautiful chalcedony and even garnets in this area is along the banks of the Mississippi River, below Blanchard Dam near Royalton. The river cannot be seen from the highway, but one clue to its existence is the heavy growth of hardwoods that lines both banks off to the west. At this point near Royalton, the river is approximately 400 feet wide below the dam at high water, but it is often much narrower during the dry months.

Staurolite crucifforms have been highly prized throughout the ages. The 90-degree twinned crystals are less frequent and a bit more difficult to find, but straight single crystals are abundant, and 60-degree-angle crosses are more readily found. A great diversity of shapes can be found here, no two crystals ever appear to be exactly alike. This is usually the case with the vast majority of our earth's minerals.

The majority of staurolite crystals to be found along the banks of the Mississippi River near Royalton are a dark chocolate brown with a shiny surface. Some have minute mica crystals bonded to their surfaces, giving them a dull, rough appearance; partially altered crystals. This most unusual mineral is formed in gneiss and schist (metamorphic boulders). Staurolite is composed of a basic silicate of iron-alu



The author screens Mississippi River gravels on the riverbank below Blanchard Dam.



nium, and is found most often at this site along the rocky shorelines on both sides of the Mississippi River below the Blanchard Dam.

Each year during spring runoff, when the water is at its highest, the exposed outcrop of graceous schistose material along the east bank below the dam is eroded away, releasing more crystal laden metamorphic rocks, loose crystals and other gemstones, heading inland. Huge boulders are often found here after the spring runoff, their surfaces showing evidence of hundreds of tightly imbedded staurolite crystals. I found it almost impossible to remove these crystals, because the host rock is tougher as a rule than the crystals. There are, however, exceptions to this rule. I have picked up pieces of decomposing schist that literally fell apart when pressure was applied, releasing the imprisoned crystals. This type of rock actually crumbles in the hands, and is quite the opposite of other extremely hard pieces of matrix in the same area. The crystals imbedded in this crumbly host rock, however, seem not to be of as good quality as those found lying loose on the ground and in the gravel beds along the banks.

Staurolite is closely associated with garnet. These minerals are not readily found in the Royalton area; at least I haven't discovered them to date. This does not necessarily mean they are not present. It takes a sharp eye and much time and patience to completely examine such a huge area as that below the Blanchard Dam.

Staurolite has a hardness of 7 to 7.5 on the Mohs scale. The cleavage is poor and one direction, lengthwise. It has a specific gravity of 3.7, give or take 0.1 percent. The crystals that I found at the site are all opaque and dark brown. Because of this coloration, those crystals lying loose in the gravel are often very easy to differentiate from the myriad light colored rocks and pebbles of which the riverbank is composed.

As mentioned earlier, chalcedony of remarkable quality is also found here. I discovered a few nodules of beautiful dark-red carnelian still embedded in the vertical bank near the dam. One is inch in diameter. The next rainstorm or high-water runoff would have easily released them from their prison. While scanning the surface of the riverbank searching for crosses, I picked up a remarkable banded agate 1 inch in diameter. It contrasts sharply with the other agates I discovered here, since it is light gray with numerous white bands exposed on one side of the nodule's lumpy surface.

The most intriguing staurolite crystals are the 90-degree angle twins; they have always held a mystical quality. Called fairy crosses (among other names), they are thought to be of some salutary value. Many are fashioned into amulets and other jewelry. Their quality and appearance is improved somewhat by trimming the cross arms and soaking them in oil.

The name of this crystal is a translation from the Greek *staurolithos*, meaning "cross." At this site, they range in size from less than 1 inch to, rarely, over 1 inch.

continued on next page

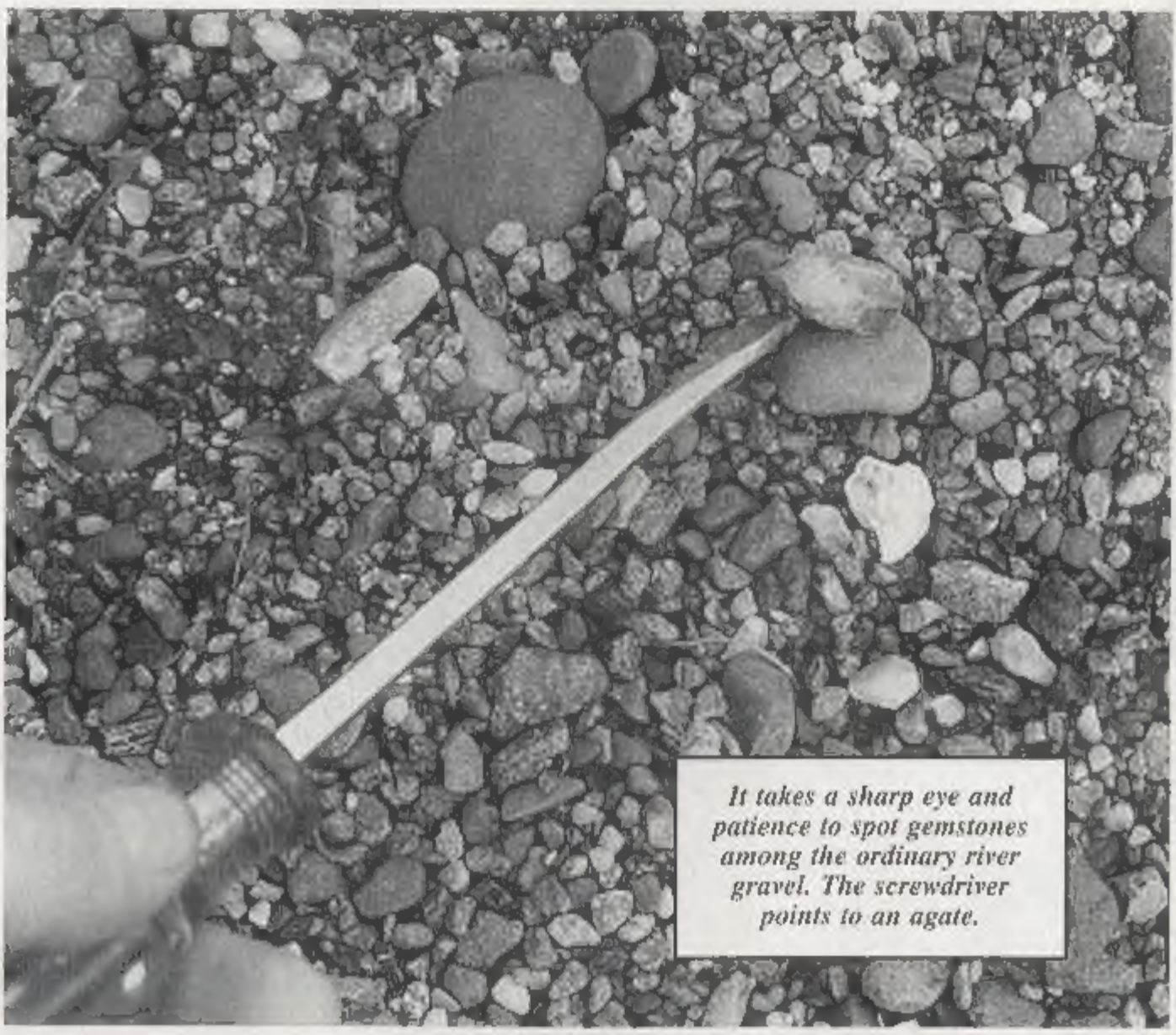
Minnesota/ *from page 81*

On my most recent field trip to Royalton, I spent the better part of a weekend at the Blanchard Dam site. My equipment consisted of a ½-inch box screen, folding shovel, rock pouch, camera, film and a plastic bucket. I didn't carry a lunch because my camper was only a few minutes away. My rock hammer was also left behind on this trip.

One local gentleman I met asked me what I was doing. When I showed him my treasures, he said he had a prize collection of twinned crystals at home and that he had often wondered what to do with them. He also mentioned that he had also found some good crosses on the other side of the river.

and the material didn't stick in the mesh as it often does when wet. This made for easy screening. In only a few loads of material, which consisted of three to five scoops from my folding shovel, I began to find crystals—*numerous* crystals. Several of them were 60-degree crosses. Many were oddly shaped, bearing little resemblance to the popular fairy crosses one sees for sale at craft shows, but I saved almost everything I recovered. The vast majority of them were single prismatic crystals, pseudohexagonal in form.

When I finally struck pay dirt that first day, it was nearing lunchtime and I had already spent the better part of the morning screening and sorting material. My method of working is this: I shake out the fine dirt,



It takes a sharp eye and patience to spot gemstones among the ordinary river gravel. The screwdriver points to an agate.

When I had negotiated the path down to the river, I noticed that the water falling over the dam was unusually high for late summer. It literally exploded over the abutments in a monstrous white wall, as millions of gallons of water plunged into the river below. Close to the dam, the noise was deafening. Of course, high water makes for less area to search for crosses along the riverbank. A few people were fishing. I saw two men turning over rocks looking for crystals. Their fishing tackle seemed to be forgotten, lying in a heap against a boulder. Evidently the fish weren't biting, so they had decided to hunt for fairy crosses instead.

When I came to the water's edge below the dam, I began to screen the various pockets of smaller gravel, tossing out the large rocks. The ground was rather dry,

place the screen on the ground and sort the remaining material, handful by handful, so that no tiny crosses can escape unless I get careless, which I did later on, tossing out a perfect cross before I realized what I'd done. I could not find it again, try as I might.

I had gone through several screens of material, and the last load before lunch produced a small bonanza of crosses. In almost every handful of gravel I found at least one cross. Two of them appear to be perfect, 90-degree twinned crystals, but few perfectly square crosses are ever found.

As the hours sped by, I tried different techniques. I even put the screen aside and got down on my hands and knees to search for crosses. In addition, I carefully and slowly walked into the sun, looking for

either the glint of a staurolite crystal or the telltale translucence of an agate. Staurolite crystals reflect sunlight like tiny mirrors and are not difficult to locate this way.

Several huge trees along the bank had been undermined by erosion and had toppled down to the river's edge. Also, a natural overhang of dirt and rocks entangled with roots juts out over this wall in several places. It extends for 200 or 300 feet downriver, below the dam. If you work in this area, use extreme caution. Don't get too far in under this overhang.

I spent the remainder of the afternoon exploring the opposite bank of the Mississippi. To do that, I had to backtrack a bit, travel west a short distance, cross the river, and drive up Mason County Road 52 until I came to the gravel access road that leads to the public landing. The west end of the dam can be easily seen from County Road 52 as you approach this access road. Since the water was high, this shoreline was not as fruitful as the east bank. There's also a steep hill to negotiate before reaching the water's edge. During low water, the pickings can sometimes be better. I did find one odd-shaped cross and several singles.

To get to Blanchard Dam from the Town of Royalton, as you're driving north on U.S. Highway 10, go west from the stoplight on County Road 26 for 2.0 miles. Turn on Hilton Road (County Road 252) and drive 2.5 miles. These roads are composed of good blacktop. Watch carefully for Township Road 305. Turn left on this gravel road and go another 0.6 miles to the parking area.

Some years ago, we were allowed to drive right down near the edge of the riverbank, but for safety reasons there is now a footpath. It's only a short walk to the river from the parking area, however.

After a marvelous sirloin steak dinner at the restaurant in Royalton right on the main thoroughfare, I spent the night in my comfortable camper at Charles A. Lindbergh State Park, approximately 12 miles from Royalton. The Lindbergh house is situated in the park and was Charles's boyhood home. Beautifully preserved, it is situated close to the Mississippi riverbank in Little Falls. It makes for quite an interesting side trip.

Although I didn't have time to investigate them, other areas in this vicinity that could prove fruitful are the Platte River gravel bars in Royalton; the gravel pits in the town of Randall, approximately nine miles north of Little Falls on U.S. Highway 10; gravel pits in and around Little Falls; and Elk Creek in Little Falls. All of these areas have produced staurolite crystals in the past, plus fortification agate and, on occasion, garnets. It could be worth your while to investigate these places if you have the time.

Much of my second morning at Blanchard Dam was spent searching for that perfect crystal that somehow always seems to elude me. I did find some nice ones. A few 90-degree crosses, although not perfect, went into my rock pouch. Search as I did, I could not find any of the larger crosses. As in any endeavor, luck plays a large part in success.

Summer weather in this part of Minnesota can get hot and humid, but the air is clear and smog-free. Biting insects can get bothersome at times and thunderstorms may come up, but for the most part it can be pleasant. In the fall, the days are mild and nights are cool, but be prepared for unexpected cold snaps. A jacket or sweater, sturdy shoes, and a hat or cap will keep you comfortable. All the collecting I did was on dry ground. There's no need to go into the water, unless you happen to see an outstanding fairy cross lying on the bottom. I didn't, although I did check the shallows from time to time.

I might add that early spring would not be the best time to visit Blanchard Dam site. The water is often extremely high, leaving little if any bank exposed on which to search for crosses.

The Mississippi River and the Blanchard Dam are an impressive sight at any time of the year, but especially during periods of high water. The continuous, turbulent plunge of water over the precipice causes a cloud of mist and spray that rises high above the top of the dam. These same millions of gallons of water eventually enter the Gulf of Mexico.

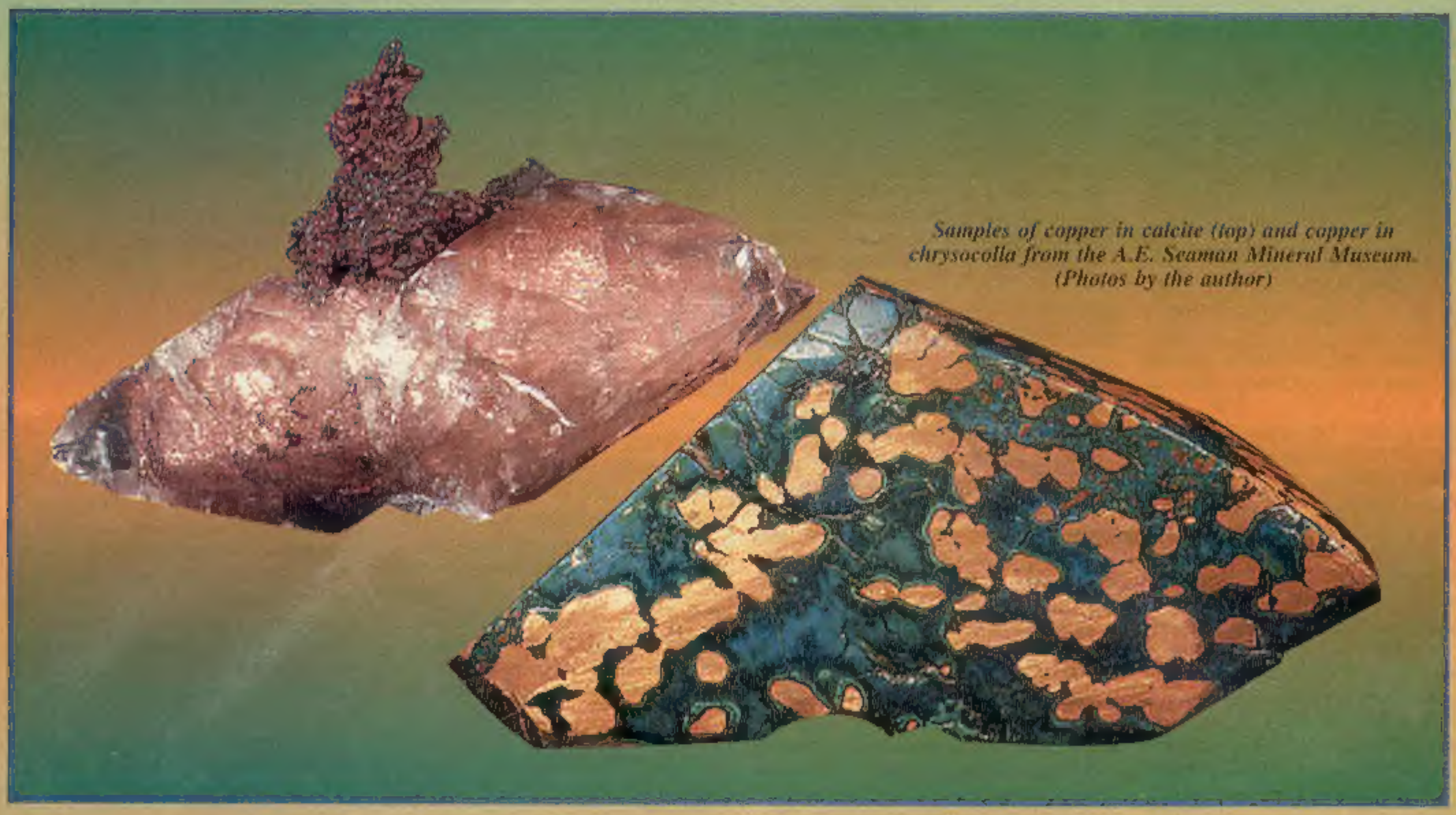
If you happen to be in the area, or are planning a vacation in Minnesota, this field trip could be like frosting on the cake. There's the excitement of finding a perfect staurolite cruciform in the next screenful of gravel, and always the possibility of an astounding agate resting at your feet, just waiting to be picked up, plus the very real beauty of the surroundings. It's only a few hours in any direction from most metropolitan areas, and it can be reached on excellent highways. So why not give it a try? I had a great time. You can, too.

Metamorphic boulders full of staurolite crystals, which are nearly impossible to extricate, periodically wash out of the riverbanks.

On the Rocks

by Bob Jones

Michigan and Arizona, Linked by Copper



Samples of copper in calcite (top) and copper in chrysocolla from the A.E. Seaman Mineral Museum. (Photos by the author)

Anyone who has read my columns for some time knows I'm a copper mineral collector. Living in Arizona, a collector can't help but fall in love with azurite, malachite, native copper, chrysocolla and the hundreds of other rare and colorful copper gems and minerals. How many of you have, for example, been impressed with the limpid blue color of gem silica, chalcedony softly colored by chrysocolla? How about the fiery red cuprite inclusions in chalcedony? And malachite is clearly a major favorite of the lapidary crowd.

For all the wonderful copper mines in Arizona, collectors should thank the state of Michigan. It was the copper ores of Michigan that produced much of the wealth that later was used to develop Arizona's copper deposits. And it was on the Michigan deposits that so many Arizona miners were trained.

Many Michigan miners, with their skills and families, traveled to Arizona as that state's mines opened up in the late 1800s. For these and other reasons, I feel a bond with the wonderful A.E. Seaman Mineral Museum at Michigan Tech University in Houghton, Michigan.

Michigan's Upper Peninsula copper district and the copper districts of Arizona have a filial relationship to each other, so it is no surprise that many Arizona collectors seek the fine copper and silver specimens that have come from Michigan.

Those of you who live within striking distance of the Seaman Museum should make a pilgrimage to see it. The collection there exceeds the collections of Arizona copper minerals in the best of that state's museums. I love to visit the Seaman Museum, and you will, too.

For one thing, it has a fantastic display of native copper, and silver specimens, and much, much more. Just as important, the collection represents the best of America's first real mining rush—a rush for copper, not gold! So the museum is a historical treasure as well as a mineralogical gem.

For this and other reasons, the Seaman Mineral Museum Society was formed to help Director Stan Dyl III preserve and expand this superb assemblage of minerals. Currently, the society is hard at work raising funds for new galleries for the collection.

The first phase of this effort, the Keweenaw Gallery, has been installed and is open to the public. Appropriately, because of the importance of the primary ore of the region, this wonderful gallery now houses the finest copper specimens in the Seaman collection. Along with these superbly crystallized copper specimens, the gallery offers some of the collection's best native silver specimens, including the "Buffalo" piece, a mass of crystallized copper "horned" with an array of sharp silver crystals.

Additional galleries yet to be built will house some of the collection's astounding calcite and copper-in-calcite specimens, along with fine examples of datolite and even agate from the ore deposits of the region.

Like any museum, the Seaman Museum needs as much help as it can obtain from friends, visitors and patrons. One way to raise funds is to schedule events like the Fluorescent Ball, held by the society during the summer of 2000.

Copper from the Kearsarge Lode (Reeder Collection) and native silver crystals on copper rival Arizona's copper mineral specimens.

As important as such special events are, it is the steady and generous support of those who recognize the value of such an institution that keeps a fundraising movement alive. So, you folks who have enjoyed or plan to enjoy the Seaman Museum and who look forward to a newer more exciting cluster of display galleries, do what is right: Contribute what you can.

Contributions can be sent to the Seaman Mineral Museum Society, A.E. Seaman Mineral Museum, Michigan Tech University, 1400 Townsend Drive, Houghton, MI 49931-1295.

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Another of my interests is good books on minerals and gems. A new book by Eduard Gubelin and Franz-Xaver Erni, *Gemestones: Symbols of Beauty and Power*, which I reviewed last month, is a wonderful treat. It's full of excellent information, and the color plates are stunning. Check with Geoscience Press, P.O. Box 4948, Tucson, AZ 856733-9284. At $49.95 it is a rare bargain.

My favorite new book is the revision recently done of *The Fabergé Imperial Easter Eggs*, by Tatiana Fabergé, Lynette G. Proler and Valentin V. Skurlov. Having enjoyed lunch with Ms. Fabergé and been her host at the Tucson Gem & Mineral Show has probably made me biased.

Be that as it may, the Fabergé book is without question the most comprehensive and accurate text ever done on Fabergé's most famous objets d'art, his Imperial Easter Eggs. The stunning color plates and descriptions of the famous eggs, the reproductions of original invoices, and the book's size, 8½ by 12 inches, qualify it as both a reference and a coffee-table book. My copy resides on my reference shelf.

Because of the 1917 Russian Revolution and the inbred secrecy of the ensuing regime, information on the Imperial Eggs became virtually unavailable. Tatiana and her coauthors, however, have gained access to the Russian archives in recent years and have been able to write the most accurate text ever done on those amazing works of gem art.

Three of the inaccuracies about these creations that have persisted through the 20th century include an incorrect egg count (usually said to be 56), misidentification of certain eggs as Imperial, and the number of eggs known to actually exist.

The Russian archives have shown that only 50 Imperial Eggs were made for czars Alexander III and Nicholas II. Alexander III had one egg made each year from 1885 to 1894. Upon his death, Nicholas II ordered two eggs each year: one for Czarina Alexandra, and one for the Dowager Empress Marie, Alexander's widow and Nicholas's mother. Therefore, the generally accepted count of 56 eggs has been shown to be excessive.

What accounts in part for this is the misidentification of five eggs as being Imperial: the Resurrection Egg (1889), the Blue Striped Enamel Egg, the Spring Flowers Egg (1899), the Twilight Egg (1917), and the Nicholas II Equestrian Egg (1913). The authors found no invoices in the archives to show that these five were made for a czar.

Of the 50 eggs proven by invoice research to be Imperial, eight are missing. This means the known number of eggs extant is 42. Of these, the Forbes Magazine Collection holds 12, and the Kremlin holds 11. The rest are scattered in various museums and private hands.

Another fact discovered by Tatiana and her two coauthors is that a number of eggs have been misnamed. For example, the Cathedine the Great Egg, a stunning piece in the Hillwood Museum, was referred to as the Grisaille Egg on the original invoice. The Orange Tree Egg, in the Forbes Museum, was originally named the Bay Tree Egg. The Cuckoo Egg is really the Cockerel Egg. It is good to know these eggs are proven Imperial eggs and to get the correct information about them.

Other inaccuracies that have been corrected by this text are the dates when certain eggs were produced. For example, the Imperial Colonnade Egg was assigned the date 1905, while the original invoice shows it to be a 1910 product. The Danish Palaces Egg actually was a gift at Easter 1890, not 1985 as was generally reported.

From just the smattering of information offered here, you can see the wisdom of owning this extremely well-documented and colorfully illustrated text. Each egg is shown in full color, accompanied by detailed discussion.

Of particular interest to me is the excellent Fabergé family history included in the text. How Fabergé evolved into one of the world's great jewelers, designers and goldsmiths, and how he became the "supplier to the Imperial Court" makes for fascinating reading.

You can get a copy of this superb book from Christie's Books 2000, 8 King Street, St. James's, London, England SWY 6QT.